US009304291B2

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Ye et al.

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(45) **Date of Patent: Apr. 5, 2016**

(54) **IMAGING LENS, AND ELECTRONIC APPARATUS INCLUDING THE SAME**

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(30) **Foreign Application Priority Data**

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G02B 9/60 (2006.01)
H04N 5/225 (2006.01)
G02B 13/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 9/60*** (2013.01); ***G02B 13/0045*** (2013.01); ***H04N 5/2254*** (2013.01)

(58) **Field of Classification Search**
CPC G02B 9/60; G02B 13/0045
See application file for complete search history.

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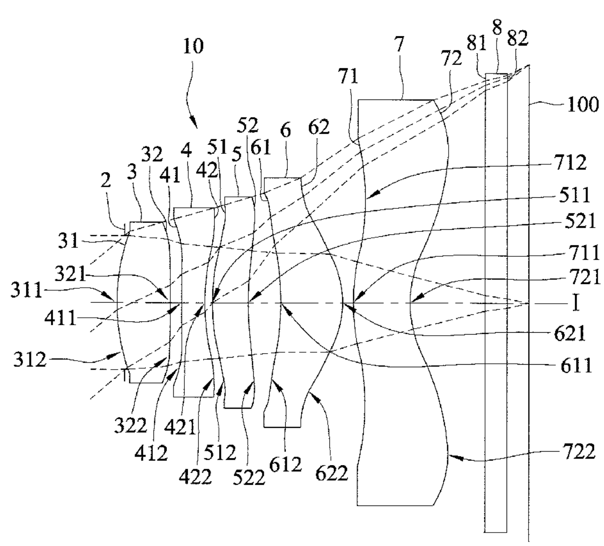
(57) **ABSTRACT**

An imaging lens includes first to fifth lens elements arranged from an object side to an image side in the given order. Through designs of surfaces of the lens elements and relevant lens parameters, a short system length of the imaging lens may be achieved while maintaining good optical performance.

19 Claims, 32 Drawing Sheets



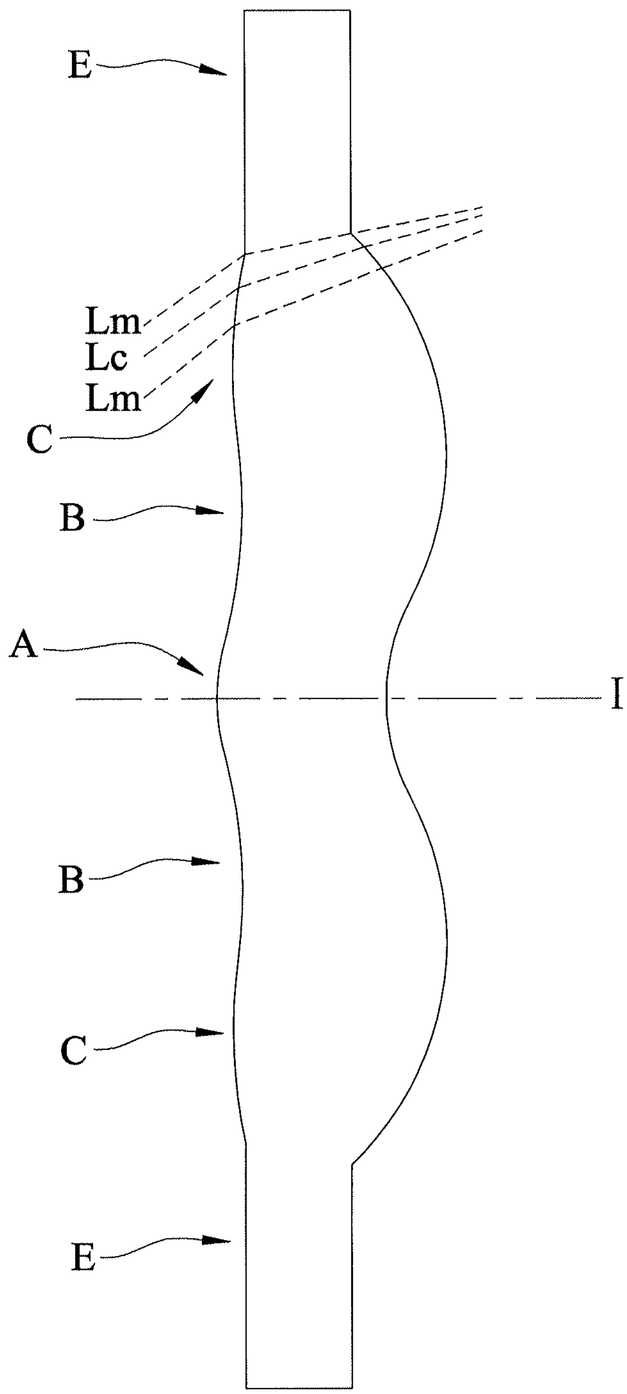


FIG.1

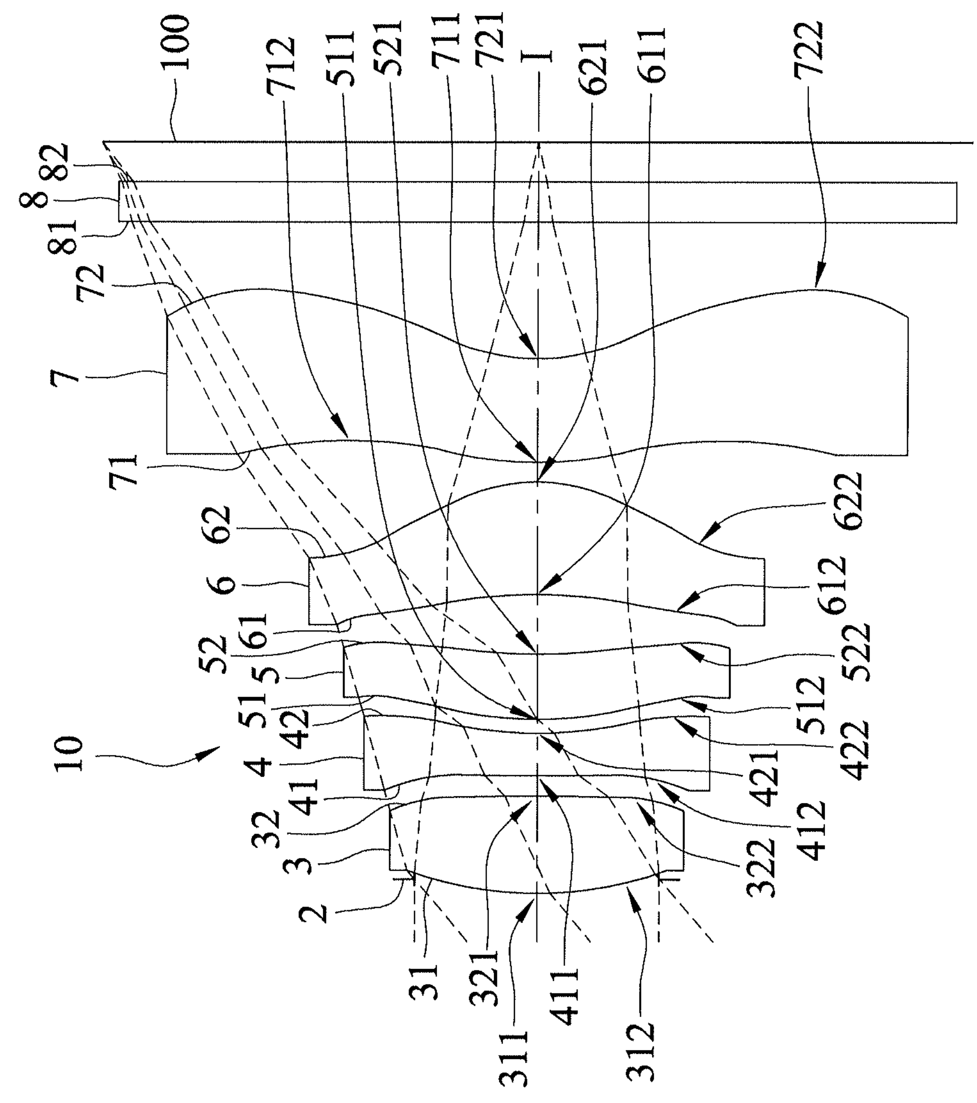

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FIG.2

system focal length =2.6385mm , half field-of-view =40.425°, F-number =2.05, system length =3.9041mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0700				
first lens element 3	object-side surface 31	1.8887	0.4924	1.544	56.114	4.131	plastic
	image-side surface 32	10.5455	0.1090				
second lens element 4	object-side surface 41	4.2016	0.2249	1.640	23.529	-3.325	plastic
	image-side surface 42	1.3894	0.0675				
third lens element 5	object-side surface 51	1.3431	0.3445	1.544	56.114	3.372	plastic
	image-side surface 52	4.5179	0.3097				
fourth lens element 6	object-side surface 61	-1.7616	0.5854	1.544	56.114	2.566	plastic
	image-side surface 62	-0.8720	0.0990				
fifth lens element 7	object-side surface 71	1.5239	0.5283	1.544	56.114	-3.453	plastic
	image-side surface 72	0.7395	0.7219				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.2114				
image plane 100		∞					

FIG.3

surface	31	32	41	42	51
K	-1.25058	0	-349.512	-29.6166	-20.6658
a4	0.048259	-0.38385	-0.41145	-0.16332	0.104392
a6	-0.59341	0.877513	1.08696	1.088485	-0.18483
a8	2.599133	-2.12598	-2.36604	-3.11735	0.028178
a10	-5.15008	0.938027	1.089712	4.911175	0.280183
a12	-0.53932	-0.86561	-3.86741	-5.66716	-0.29178
a14	14.03623	6.71362	14.53641	4.365443	-0.41178
a16	-13.0792	-6.43137	-11.4445	-1.52971	0.414082
surface	52	61	62	71	72
K	0	-13.1536	-1.26315	-5.24452	-3.737242
a4	0.070719	0.010246	0.148364	-0.21315	-0.15146235
a6	-0.15743	0.138062	-0.13576	0.131662	0.10471982
a8	-0.05711	-0.00062	0.137929	-0.05576	-0.057088882
a10	0.059285	-0.16185	0.044063	0.010466	0.020469999
a12	0.265309	-0.01146	-0.0008	0.002891	-0.00466351
a14	-0.54375	0.119576	-0.07423	-0.00174	0.000610102
a16	0.278334	-0.05477	0.028733	0.000225	-3.53759E-05

FIG.4

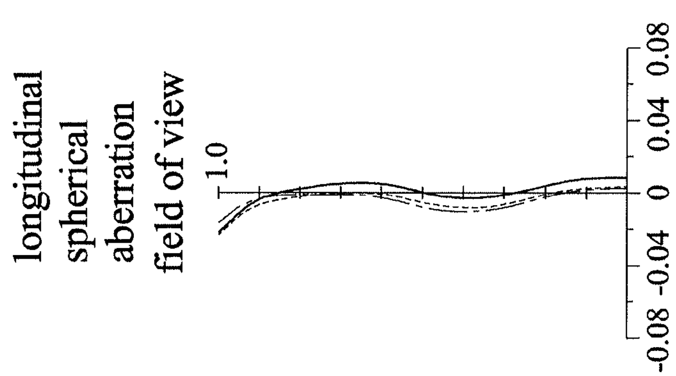

FIG.5(a)

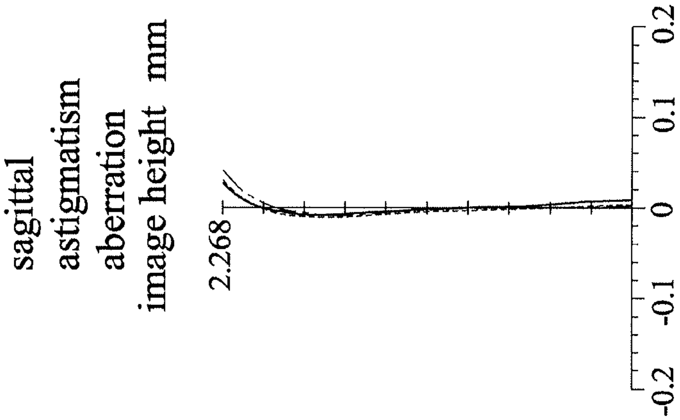

FIG.5(b)

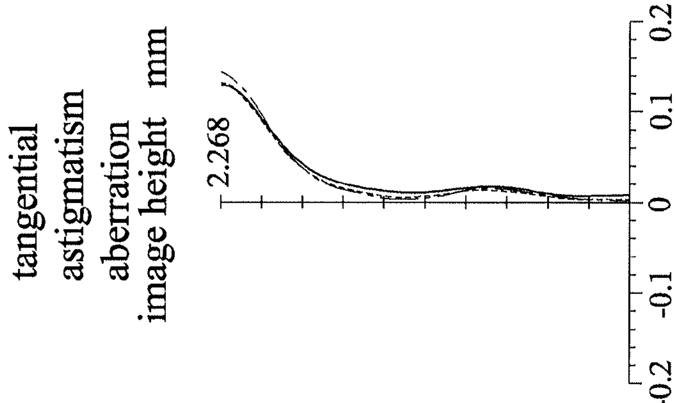

FIG.5(c)

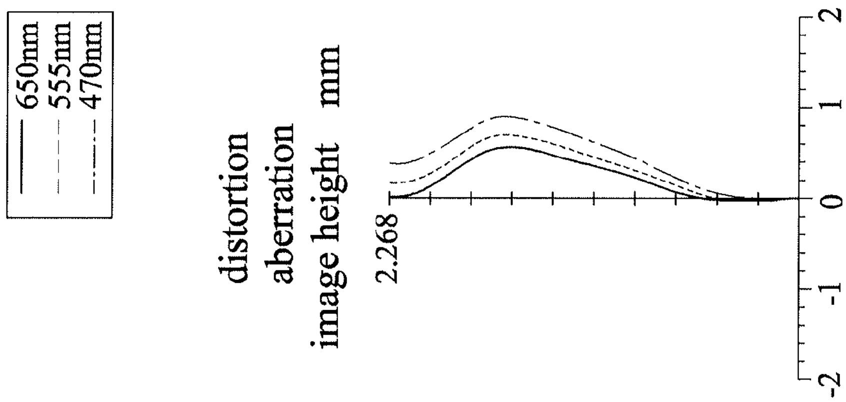

FIG.5(d)

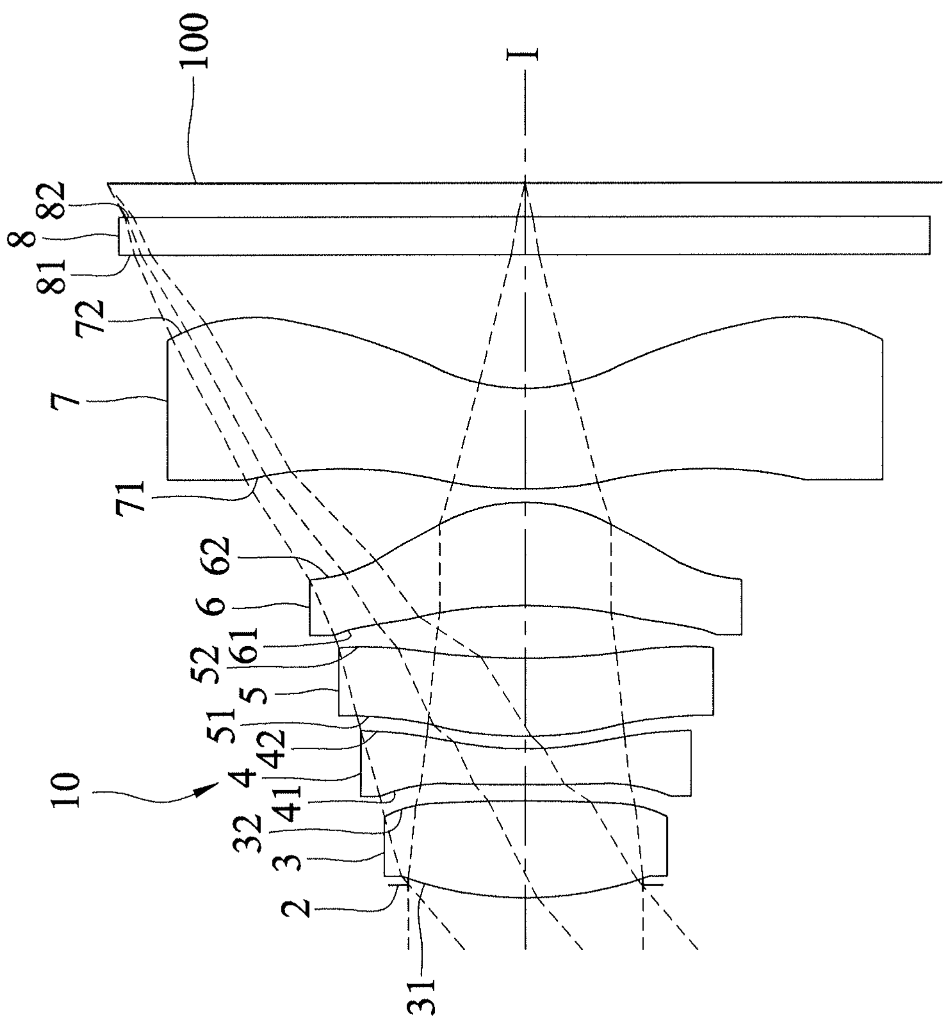

FIG.6

system focal length =2.6174mm , half field-of-view =40.650°, F-number =2.05, system length =3.8859mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0700				
first lens element 3	object-side surface 31	1.8887	0.5113	1.544	56.114	4.128	plastic
	image-side surface 32	10.5455	0.1018				
second lens element 4	object-side surface 41	4.2016	0.1941	1.640	23.529	-3.31	plastic
	image-side surface 42	1.3894	0.0582				
third lens element 5	object-side surface 51	1.3431	0.4339	1.544	56.114	3.34	plastic
	image-side surface 52	4.5179	0.2894				
fourth lens element 6	object-side surface 61	-1.7616	0.5553	1.544	56.114	2.592	plastic
	image-side surface 62	-0.8720	0.0733				
fifth lens element 7	object-side surface 71	1.5239	0.5480	1.544	56.114	-3.493	plastic
	image-side surface 72	0.7395	0.7369				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.1737				
image plane 100		∞					

FIG.7

surface	31	32	41	42	51
K	-1.25058	0	-349.512	-29.6166	-20.6658
a4	0.041629	-0.38077	-0.39276	-0.16417	0.090995
a6	-0.58486	0.870191	1.115721	1.110383	-0.18553
a8	2.56306	-2.13368	-2.34538	-3.09887	0.030199
a10	-5.13958	0.942333	1.066189	4.816563	0.288627
a12	-0.50134	-0.85182	-3.95181	-5.64372	-0.28773
a14	14.2852	6.958231	14.44963	4.435266	-0.41345
a16	-13.4986	-6.71434	-11.304	-1.5968	0.409132
surface	52	61	62	71	72
K	0	-13.1536	-1.26315	-5.24452	-3.737242
a4	0.076409	0.010321	0.130111	-0.2146	-0.14686611
a6	-0.13072	0.125174	-0.11657	0.135698	0.10396848
a8	-0.09264	0.020034	0.123919	-0.05669	-0.057004537
a10	0.062105	-0.17199	0.051374	0.010279	0.020491926
a12	0.295976	-0.0136	-0.00117	0.002918	-0.004641992
a14	-0.52532	0.116279	-0.07867	-0.00173	0.000600045
a16	0.253032	-0.0518	0.03063	0.000215	-3.45E-05

FIG. 8

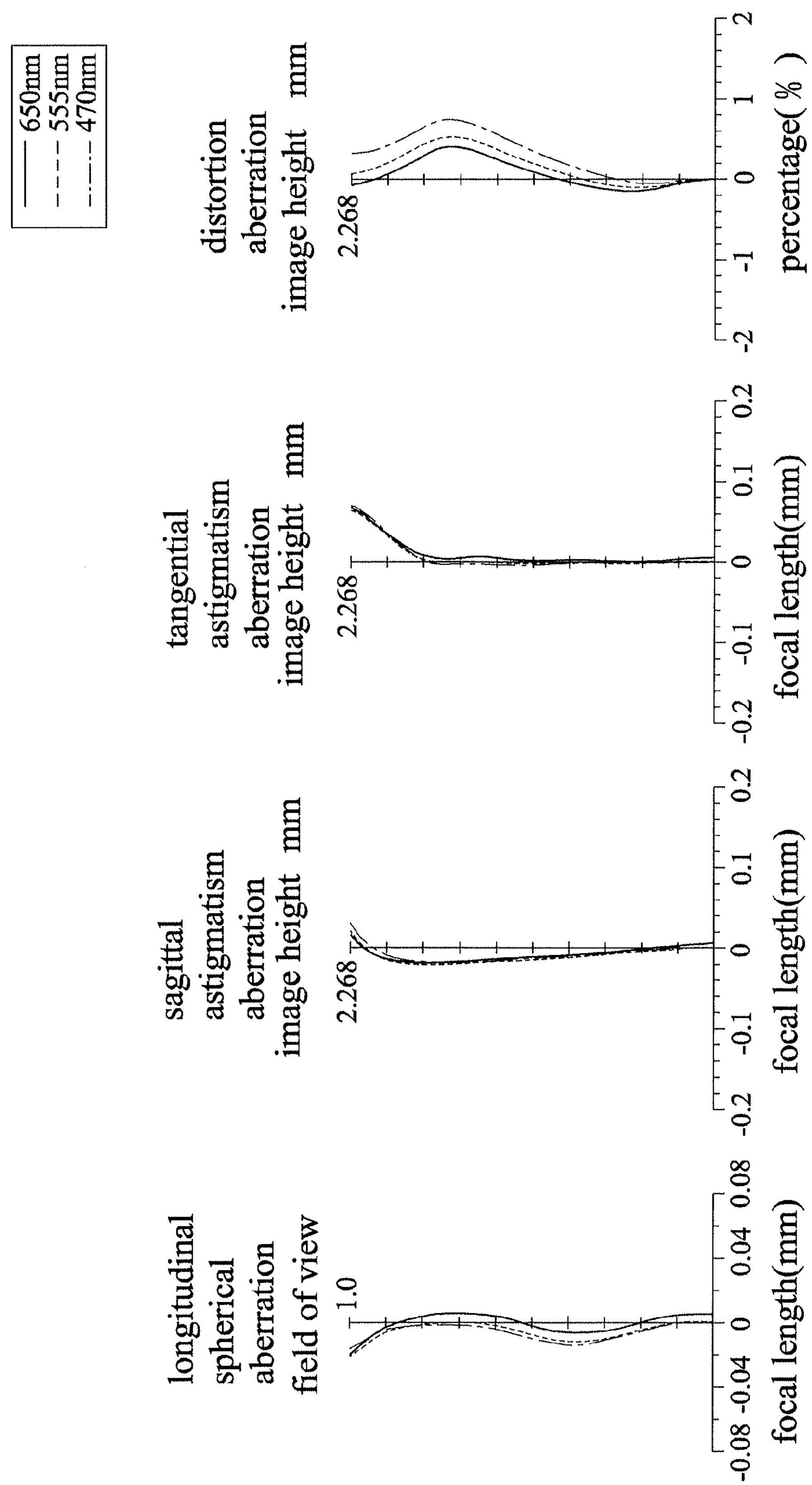

FIG.9(a) FIG.9(b) FIG.9(c) FIG.9(d)

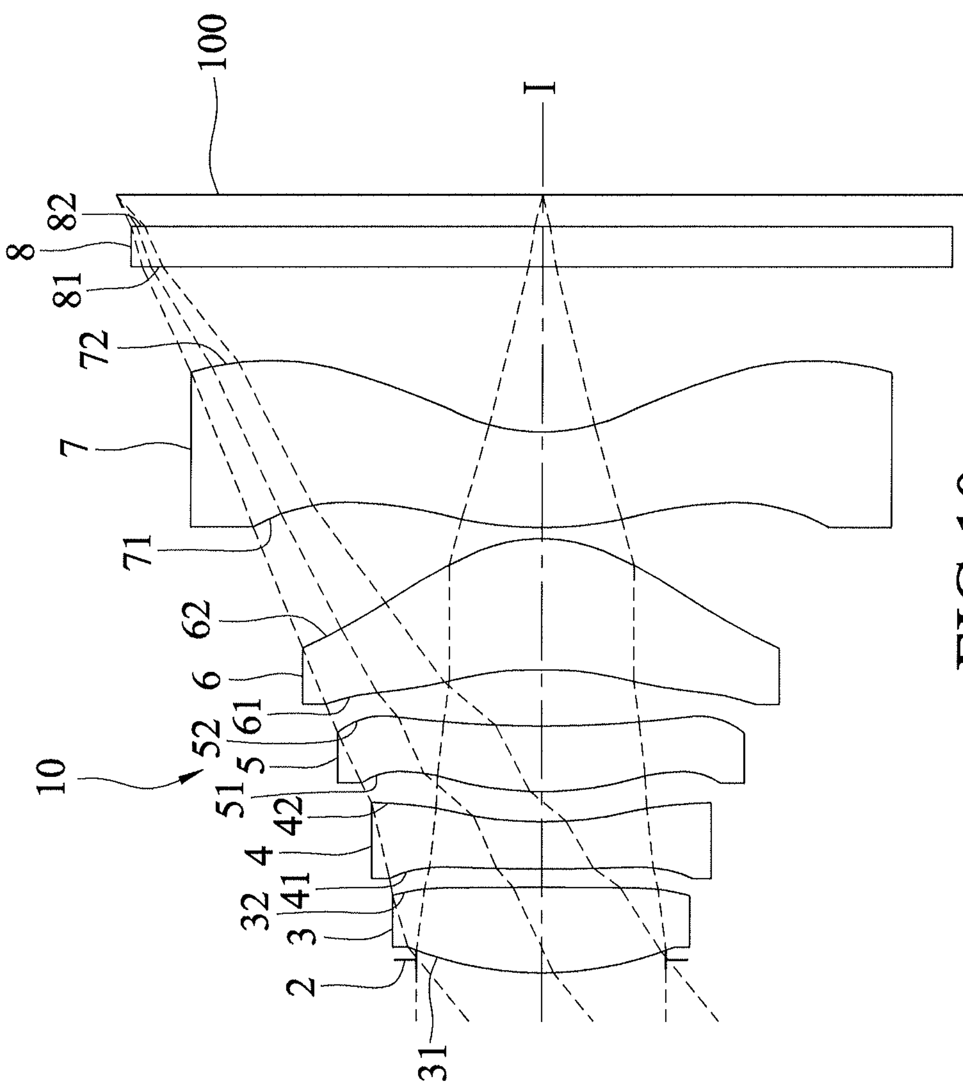

FIG.10

system focal length =2.7389mm , half field-of-view =39.421°, F-number =2.05, system length =4.1354mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0700				
first lens element 3	object-side surface 31	1.8887	0.4535	1.544	56.114	4.138	plastic
	image-side surface 32	10.5455	0.1020				
second lens element 4	object-side surface 41	4.2016	0.2499	1.640	23.529	-3.337	plastic
	image-side surface 42	1.3894	0.1599				
third lens element 5	object-side surface 51	1.3431	0.3498	1.544	56.114	3.37	plastic
	image-side surface 52	4.5179	0.3006				
fourth lens element 6	object-side surface 61	-1.7616	0.6950	1.544	56.114	2.479	plastic
	image-side surface 62	-0.8720	0.0600				
fifth lens element 7	object-side surface 71	1.5239	0.4990	1.544	56.114	-3.394	plastic
	image-side surface 72	0.7395	0.8879				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.1679				
image plane 100		∞					

FIG.11

surface	31	32	41	42	51
K	-1.25058	0	-349.512	-29.6166	-20.6658
a4	0.006174	-0.44067	-0.51874	-0.19991	0.12439
a6	-0.25448	1.628621	1.630671	1.070038	-0.43506
a8	1.972845	-3.26849	-2.32627	-2.72501	0.327903
a10	-4.80972	1.793812	0.726056	4.369754	0.136255
a12	-0.01444	-1.06559	-5.13722	-5.61388	-0.35659
a14	13.85504	5.173052	14.48788	4.764183	-0.32066
a16	-13.5717	-4.68706	-9.64525	-1.73718	0.374623
surface	52	61	62	71	72
K	0	-13.1536	-1.26315	-5.24452	-3.737242
a4	-0.07727	-0.10524	0.105886	-0.19199	-0.13755142
a6	0.157305	0.181849	-0.09969	0.133912	0.10022582
a8	-0.20932	0.161457	0.054842	-0.06666	-0.057813353
a10	-0.06555	-0.20383	0.035442	0.008198	0.020611258
a12	0.374075	-0.08945	0.024607	0.004343	-0.004565491
a14	-0.49671	0.107172	-0.06019	-0.0012	0.000602481
a16	0.212502	-0.0168	0.0194	5.26E-05	-3.64E-05

FIG.12

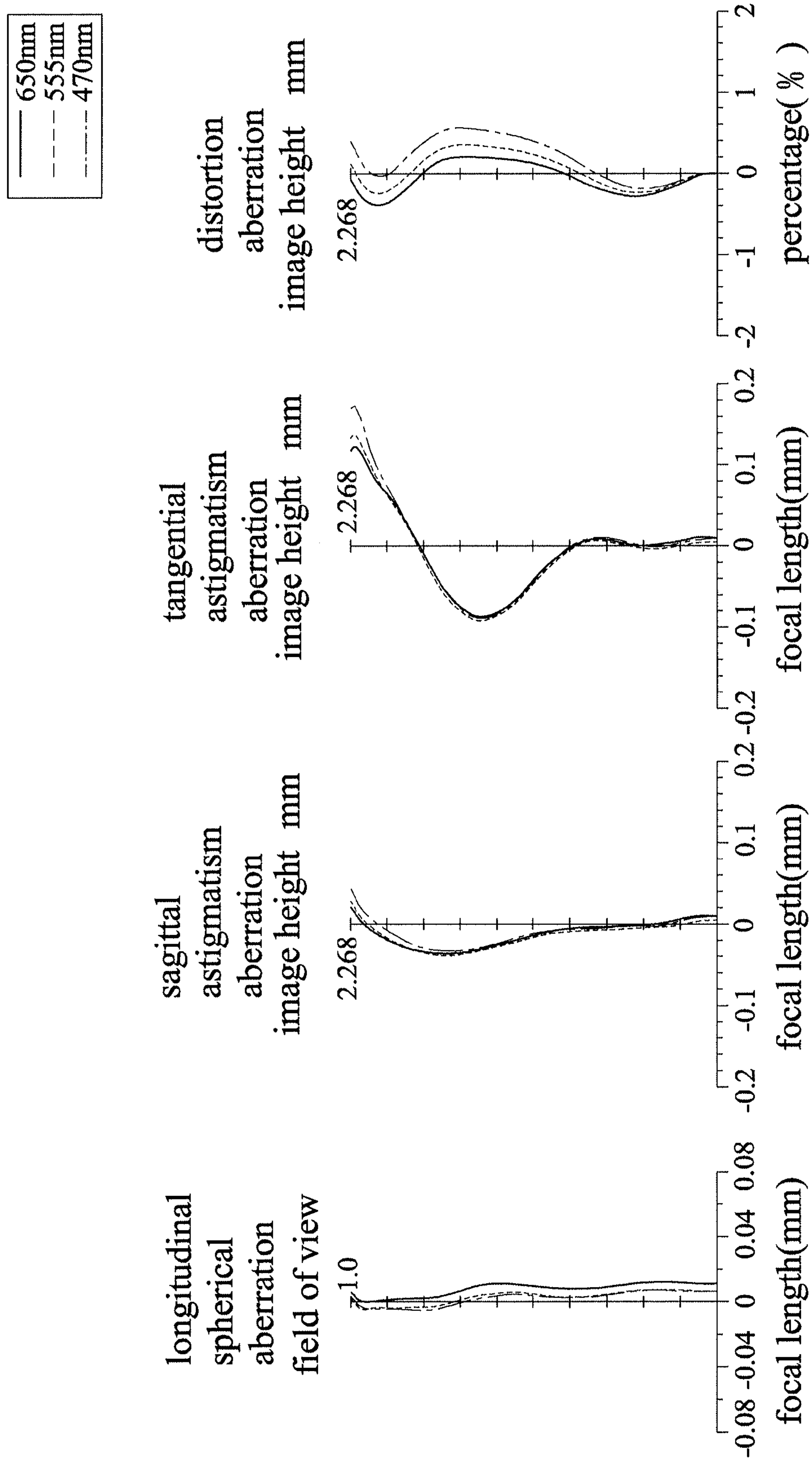

FIG.13(a)

FIG.13(b)

FIG.13(c)

FIG.13(d)

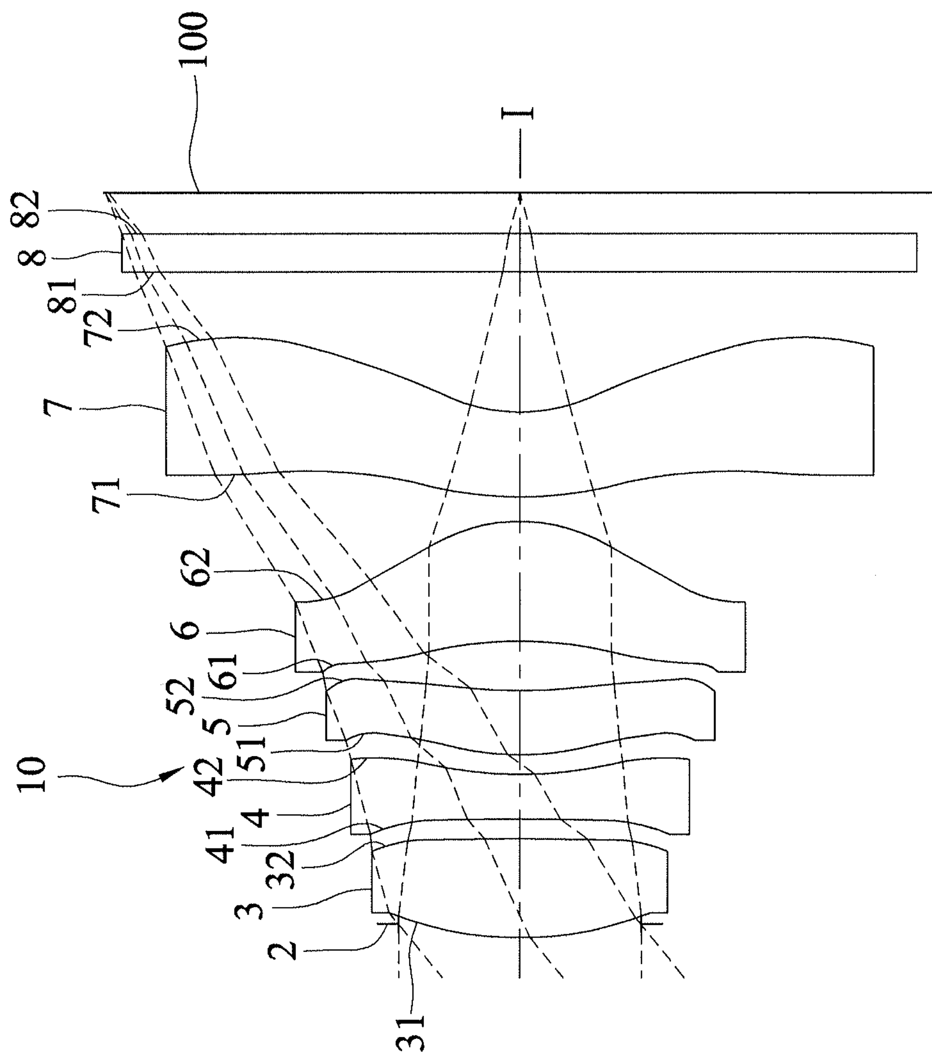

FIG.14

system focal length =2.7359mm , half field-of-view =39.385°, F-number =2.05, system length =4.0700mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0700				
first lens element 3	object-side surface 31	1.8887	0.5331	1.544	56.114	4.125	plastic
	image-side surface 32	10.5455	0.1036				
second lens element 4	object-side surface 41	4.2016	0.2500	1.640	23.529	-3.337	plastic
	image-side surface 42	1.3894	0.1129				
third lens element 5	object-side surface 51	1.3431	0.3500	1.544	56.114	3.37	plastic
	image-side surface 52	4.5179	0.2608				
fourth lens element 6	object-side surface 61	-1.7616	0.6482	1.544	56.114	2.516	plastic
	image-side surface 62	-0.8720	0.1377				
fifth lens element 7	object-side surface 71	1.5239	0.4676	1.544	56.114	-3.333	plastic
	image-side surface 72	0.7395	0.7634				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.2328				
image plane 100		∞					

FIG.15

surface	31	32	41	42	51
K	-1.25058	0	-349.512	-29.6166	-20.6658
a4	0.043552	-0.40867	-0.44598	-0.20878	0.047963
a6	-0.493322	1.22689	1.146301	1.056428	-0.18911
a8	2.407371	-2.66271	-2.01317	-2.83359	0.055991
a10	-4.67161	1.389239	1.055449	4.699251	0.319067
a12	-0.73914	-0.72549	-4.76647	-5.84331	-0.29909
a14	12.65435	6.013906	14.24426	4.61407	-0.43788
a16	-11.1244	-6.05773	-10.4063	-1.58258	0.38267
surface	52	61	62	71	72
K	0	-13.1536	-1.26315	-5.24452	-3.737242
a4	-0.00818	-0.07085	0.122874	-0.20517	-0.14622368
a6	-0.04658	0.178858	-0.12319	0.147352	0.10553557
a8	-0.05946	0.093724	0.122575	-0.06093	-0.055931724
a10	0.05351	-0.16471	0.044714	0.007918	0.019630475
a12	0.277959	-0.04019	0.003995	0.003253	-0.004516684
a14	-0.52691	0.099632	-0.06836	-0.00123	0.000613672
a16	0.224481	-0.04514	0.024815	0.000117	-3.63E-05

FIG.16

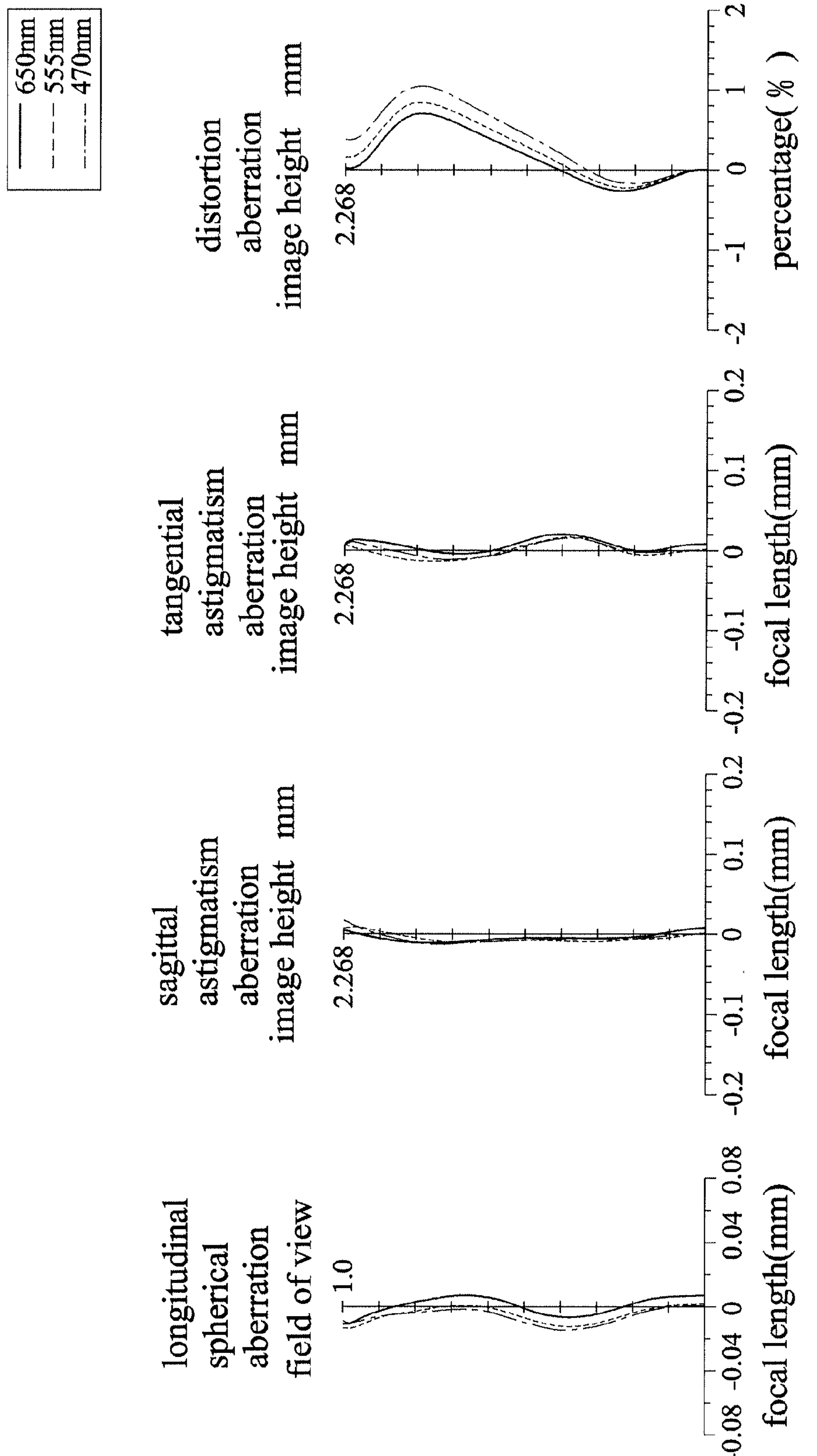

FIG.17(a) FIG.17(b) FIG.17(c) FIG.17(d)

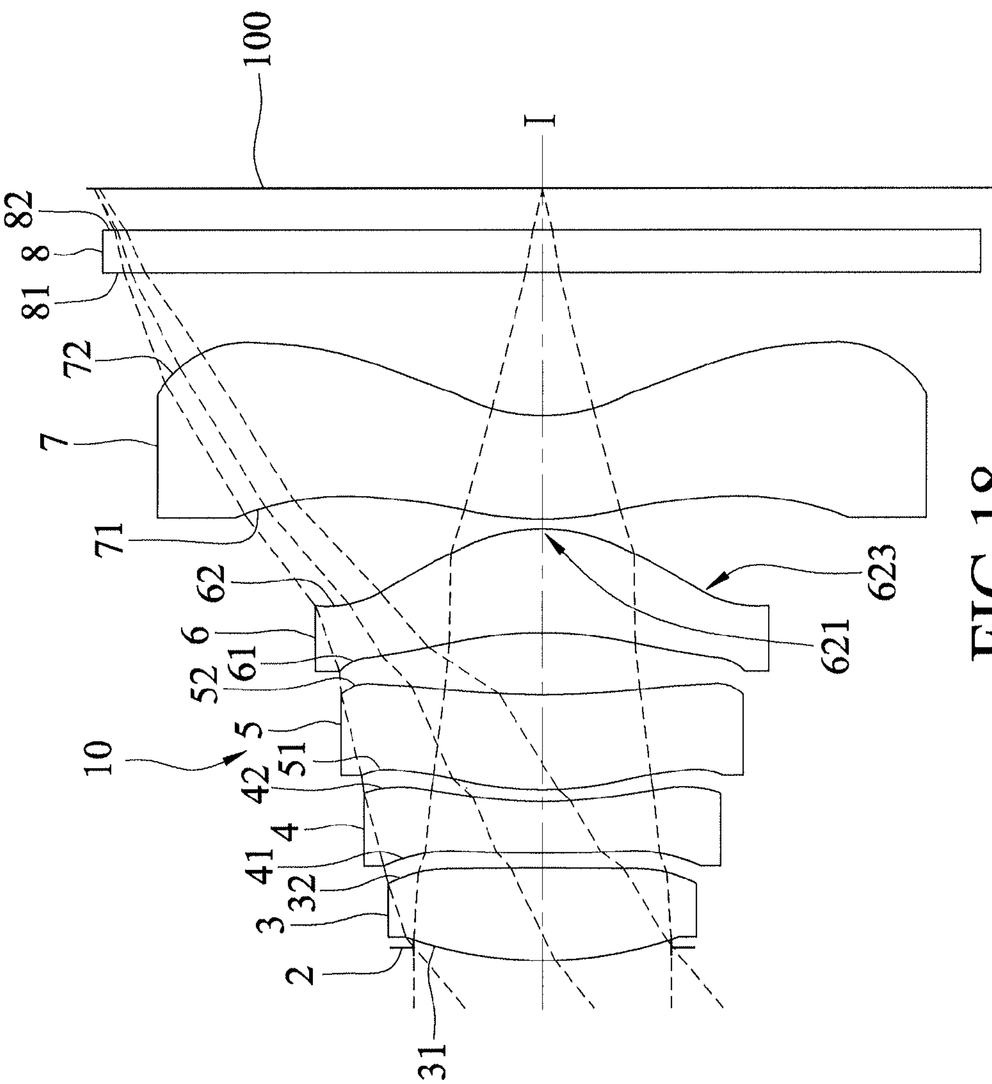

FIG.18

system focal length =2.6899mm , half field-of-view =39.812°, F-number =2.05, system length =3.9004mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0700				
first lens element 3	object-side surface 31	1.8887	0.4636	1.544	56.114	4.136	plastic
	image-side surface 32	10.5455	0.0819				
second lens element 4	object-side surface 41	4.2016	0.2500	1.640	23.529	-3.337	plastic
	image-side surface 42	1.3894	0.0600				
third lens element 5	object-side surface 51	1.3431	0.4799	1.544	56.114	3.323	plastic
	image-side surface 52	4.5179	0.3201				
fourth lens element 6	object-side surface 61	-1.7616	0.5151	1.544	56.114	2.626	plastic
	image-side surface 62	-0.8720	0.0602				
fifth lens element 7	object-side surface 71	1.5239	0.5194	1.544	56.114	-3.435	plastic
	image-side surface 72	0.7395	0.7209				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.2193				
image plane 100		∞					

FIG.19

surface	31	32	41	42	51
K	-1.25058	0	-349.512	-29.6166	-20.6658
a4	-0.03034	-0.42081	-0.38844	-0.25006	0.014534
a6	-0.11947	1.105302	1.006989	1.052578	-0.16266
a8	1.283638	-2.7025	-1.98363	-2.78066	0.063889
a10	-3.36051	1.550886	1.079133	4.611719	0.370318
a12	-1.61979	-0.81361	-4.61253	-5.79351	-0.54374
a14	13.50099	5.871113	14.38828	4.510678	-0.25004
a16	-11.8897	-5.64566	-10.7308	-1.55813	0.368378
surface	52	61	62	71	72
K	0	-13.1536	-1.26315	-5.24452	-3.737242
a4	0.053966	-0.02487	0.126925	-0.22674	-0.15682649
a6	-0.10761	0.057287	-0.1075	0.142245	0.10904341
a8	-0.08586	0.131617	0.114194	-0.05607	-0.057551848
a10	0.060272	-0.16758	0.050356	0.006611	0.01991916
a12	0.281555	-0.03191	0.006517	0.003435	-0.004482402
a14	-0.52483	0.092068	-0.06915	-0.00128	0.000578333
a16	0.235126	-0.05758	0.024754	0.000127	-3.33E-05

FIG.20

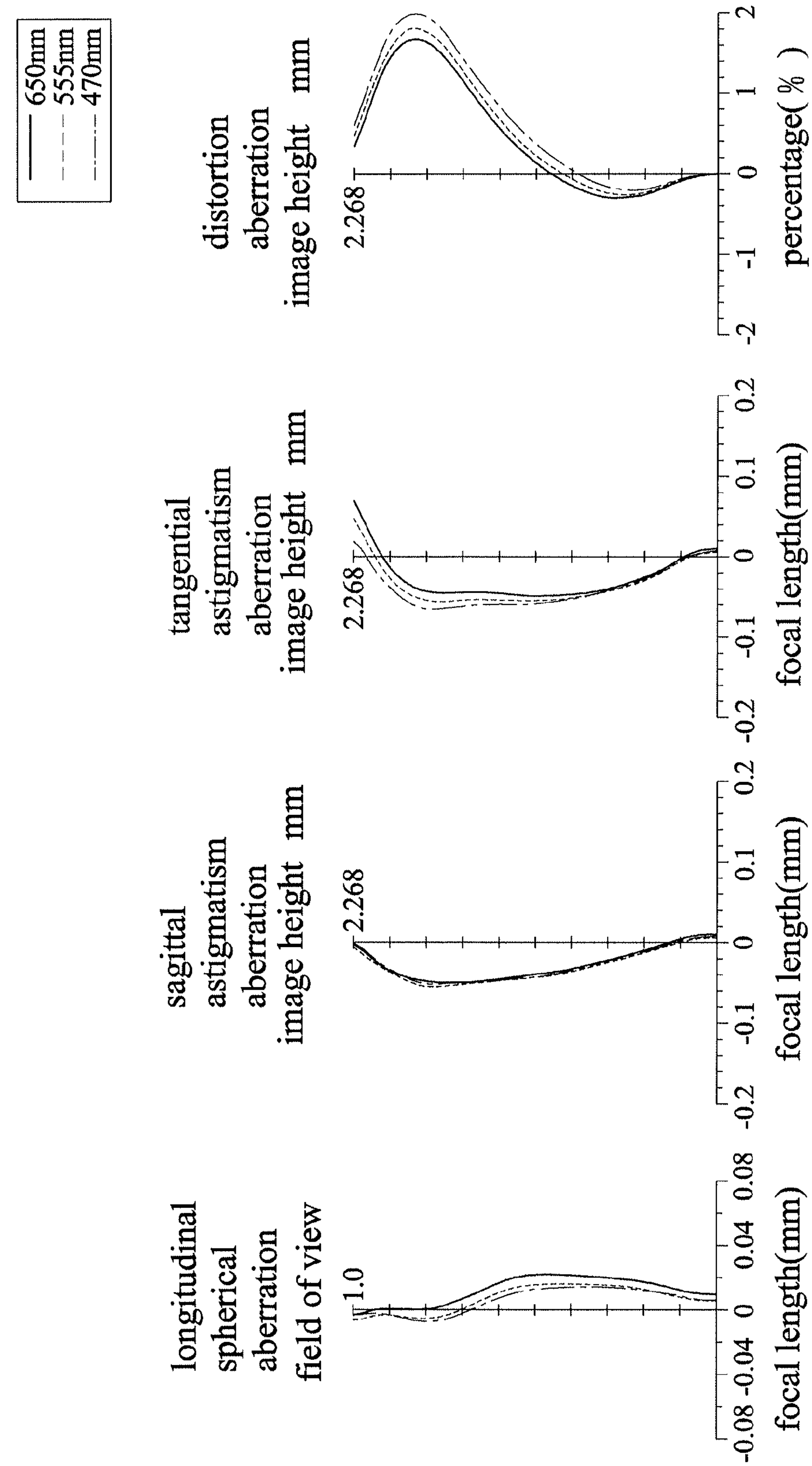

FIG.21(a)

FIG.21(b)

FIG.21(c)

FIG.21(d)

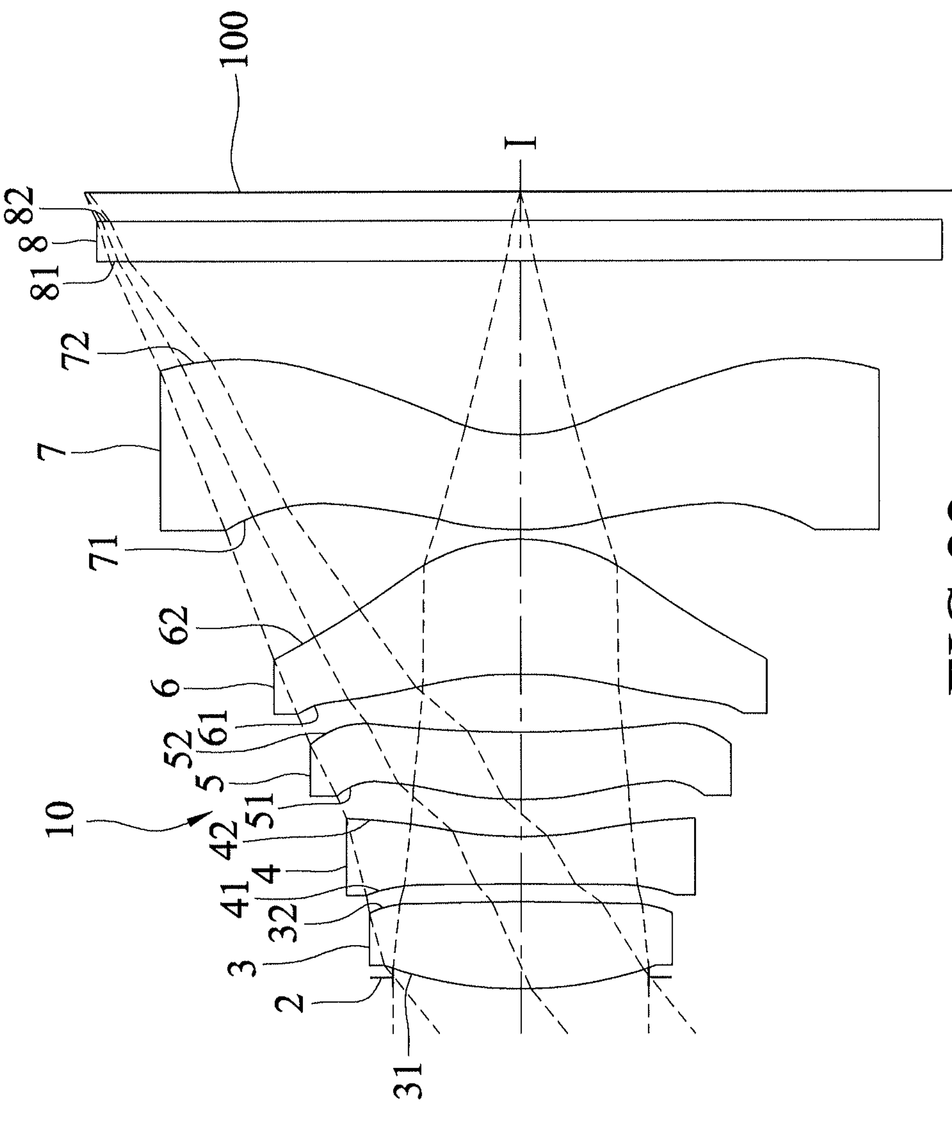

FIG.22

system focal length =2.7384mm , half field-of-view =39.418°, F-number =2.05, system length =4.1644mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0700				
first lens element 3	object-side surface 31	1.9615	0.4494	1.544	56.114	4.001	plastic
	image-side surface 32	17.6821	0.0960				
second lens element 4	object-side surface 41	5.2309	0.2499	1.640	23.529	-3.727	plastic
	image-side surface 42	1.6155	0.1930				
third lens element 5	object-side surface 51	1.5158	0.3498	1.544	56.114	3.907	plastic
	image-side surface 52	4.8113	0.3051				
fourth lens element 6	object-side surface 61	-1.7611	0.6946	1.544	56.114	2.422	plastic
	image-side surface 62	-0.8605	0.0600				
fifth lens element 7	object-side surface 71	1.5469	0.4926	1.544	56.114	-3.284	plastic
	image-side surface 72	0.7370	0.9127				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.1513				
image plane 100		∞					

FIG.23

surface	31	32	41	42	51
K	-1.3804	0	-558.672	-32.1986	-21.7963
a4	0.003079	-0.44074	-0.51545	-0.20565	0.1133
a6	-0.26579	1.63617	1.635882	1.066256	-0.44247
a8	1.971276	-3.26247	-2.31939	-2.72515	0.324329
a10	-4.79064	1.78997	0.734225	4.373387	0.135808
a12	0.007337	-1.07502	-5.13449	-5.61057	-0.35574
a14	13.85037	5.175221	14.48689	4.763608	-0.31996
a16	-13.6857	-4.64283	-9.65745	-1.74339	0.373988
surface	52	61	62	71	72
K	0	-11.4866	-1.26269	-4.77485	-3.608603
a4	-0.08144	-0.10557	0.105215	-0.19365	-0.13680452
a6	0.154426	0.182775	-0.10039	0.13333	0.10024791
a8	-0.20979	0.1615	0.054342	-0.06676	-0.05783367
a10	-0.06539	-0.20403	0.035194	0.008199	0.020605009
a12	0.374094	-0.08975	0.024466	0.004348	-0.004566176
a14	-0.49716	0.106996	-0.06027	-0.0012	0.000602479
a16	0.211891	-0.01688	0.019357	5.30E-05	-3.63E-05

FIG.24

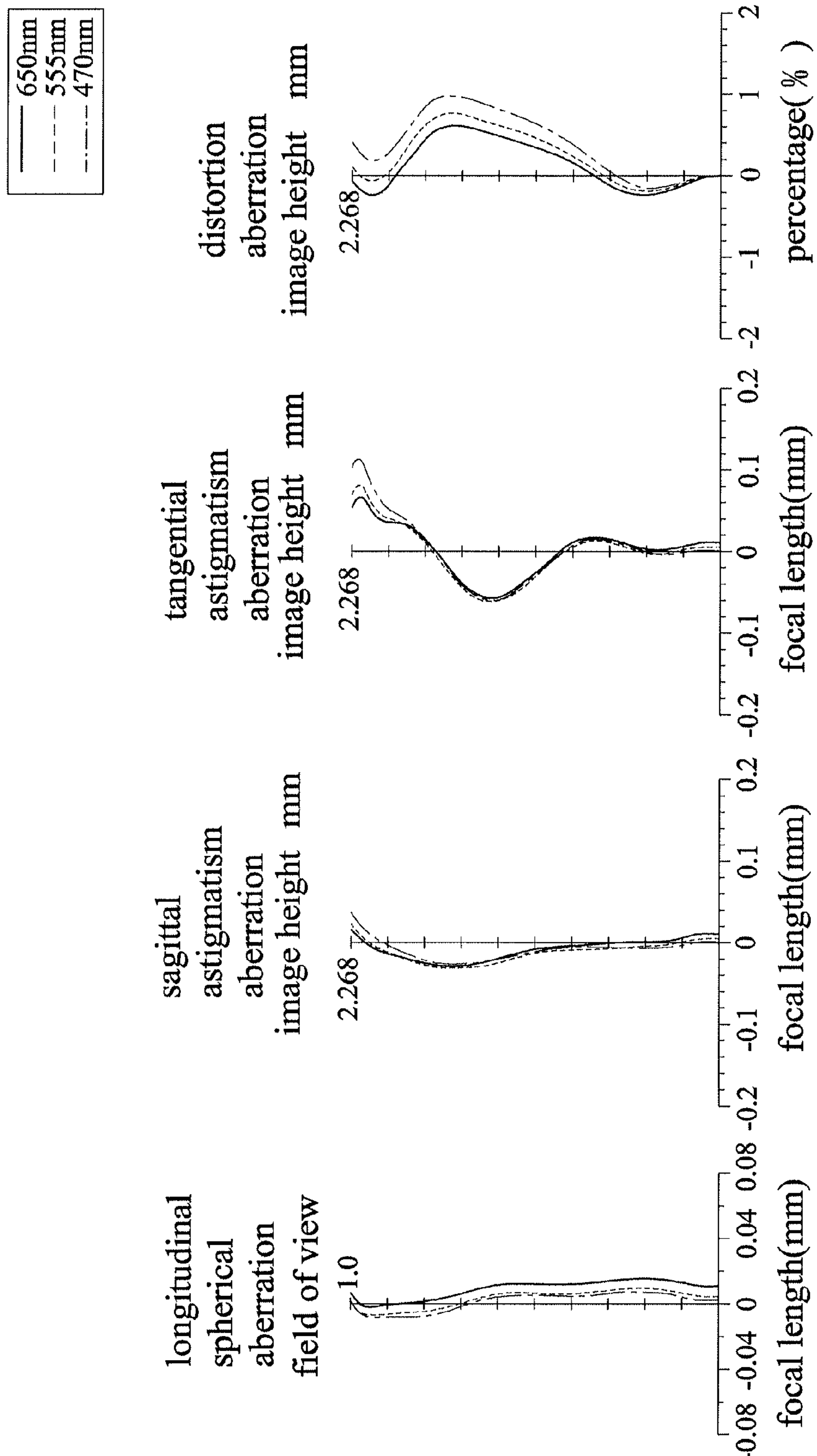

FIG.25(a) FIG.25(b) FIG.25(c) FIG.25(d)

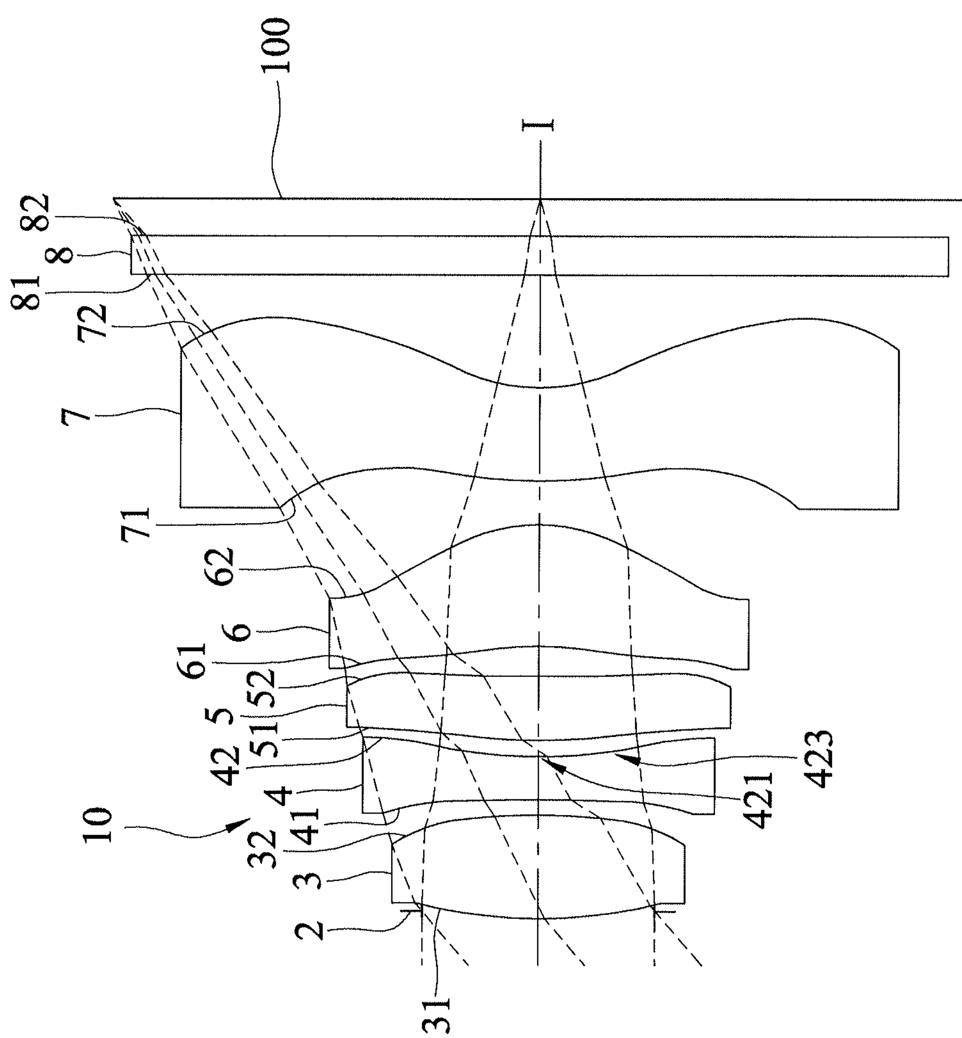

FIG.26

system focal length =2.5570mm , half field-of-view =41.121°, F-number =2.05 system length =3.8139mm							
lens element	surface	radius of curvature	thickness	refractive index	Abbe number	focal length	material
object		∞	300.0000				
aperture stop 2		∞	-0.0400				
first lens element 3	object-side surface 31	2.2931	0.5373	1.544	56.114	2.712	plastic
	image-side surface 32	-3.8342	0.0873				
second lens element 4	object-side surface 41	58.2304	0.2290	1.640	23.529	-3.322	plastic
	image-side surface 42	2.0622	0.0906				
third lens element 5	object-side surface 51	2.2077	0.3342	1.535	55.712	6.547	plastic
	image-side surface 52	5.6242	0.1583				
fourth lens element 6	object-side surface 61	-2.0324	0.6437	1.535	55.712	2.224	plastic
	image-side surface 62	-0.8352	0.2399				
fifth lens element 7	object-side surface 71	2.0837	0.4925	1.531	55.744	-2.548	plastic
	image-side surface 72	0.7545	0.6000				
optical filter 8	object-side surface 81	∞	0.2100				
	image-side surface 82	∞	0.1911				
image plane 100		∞					

FIG.27

surface	31	32	41	42	51
K	-1.98621	-80.274	-1057.3	-22.3332	-20.7873
a4	-0.01094	-0.21615	-0.04457	0.032506	-0.1664
a6	-0.27002	-0.07256	-0.38019	0.099549	0.075709
a8	0.636639	-0.15898	0.217682	-0.59075	0.059667
a10	-0.9837	-0.25048	-0.45532	0.488929	-0.03537
a12	-0.32964	0.636554	-0.29969	0.080987	-0.15221
a14	0.051586	0.312276	3.673763	-0.148	0.235825
a16	1.4444	-0.43232	-3.02067	0.002353	-0.08781
surface	52	61	62	71	72
K	0	-7.87988	-0.87291	-2.40705	-3.847707
a4	-0.0216	0.201269	0.346394	-0.23268	-0.11452123
a6	-0.09077	-0.02262	-0.34142	0.055926	0.048948105
a8	-0.05872	-0.14508	0.278858	0.001525	-0.014921816
a10	-0.01545	0.000836	0.019133	-0.00569	0.001840525
a12	0.053424	0.037043	-0.05312	-0.00058	0.000190381
a14	0	0.029085	-0.02595	0.00065	-8.90E-05
a16	0	-0.01918	0.020793	5.30E-05	7.41E-06

FIG.28

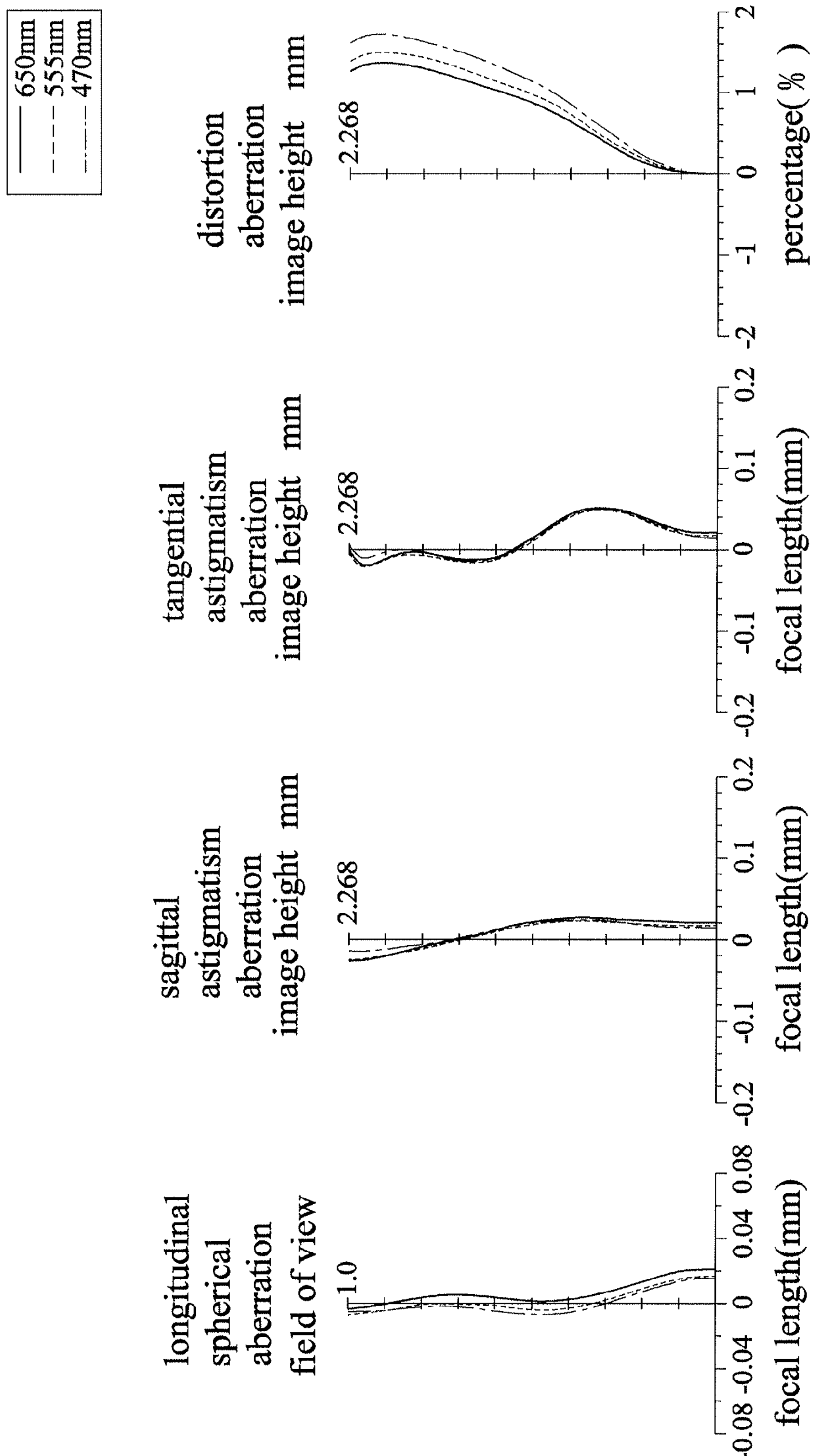

FIG.29(a)

FIG.29(b)

FIG.29(c)

FIG.29(d)

relationship	first preferred embodiment	second preferred embodiment	third preferred embodiment	fourth preferred embodiment	fifth preferred embodiment	sixth preferred embodiment	seventh preferred embodiment
T4/G34	1.890	1.919	2.312	2.486	1.609	2.277	4.066
T5/T4	0.903	0.987	0.718	0.721	1.008	0.709	0.765
BFL/(G12+G45)	5.494	6.401	7.817	4.999	8.095	8.164	3.060
T3/G23	5.104	7.452	2.188	3.101	7.998	1.812	3.688
T3/G34	1.112	1.500	1.164	1.342	1.499	1.147	2.111
T1/Gaa	0.841	0.978	0.729	0.867	0.888	0.687	0.933
T2/G23	3.332	3.333	1.563	2.215	4.167	1.295	2.528
ALT/T1	4.418	4.386	4.955	4.219	4.806	4.977	4.163
T1/G23	7.296	8.781	2.836	4.723	7.726	2.328	5.931
(G12+G45)/G23	3.083	3.007	1.013	2.138	2.368	0.808	3.611
BFL/T5	2.164	2.045	2.537	2.580	2.214	2.586	2.033
Gaa/(G12+G45)	2.813	2.985	3.844	2.549	3.675	4.192	1.761
T5/G23	7.828	9.410	3.121	4.142	8.657	2.552	5.436
Gaa/T2	2.602	2.693	2.491	2.460	2.089	2.617	2.515
T4/G23	8.674	9.537	4.346	5.743	8.585	3.599	7.104
ALT/G23	32.235	38.513	14.053	19.923	37.133	11.586	24.687

FIG.30

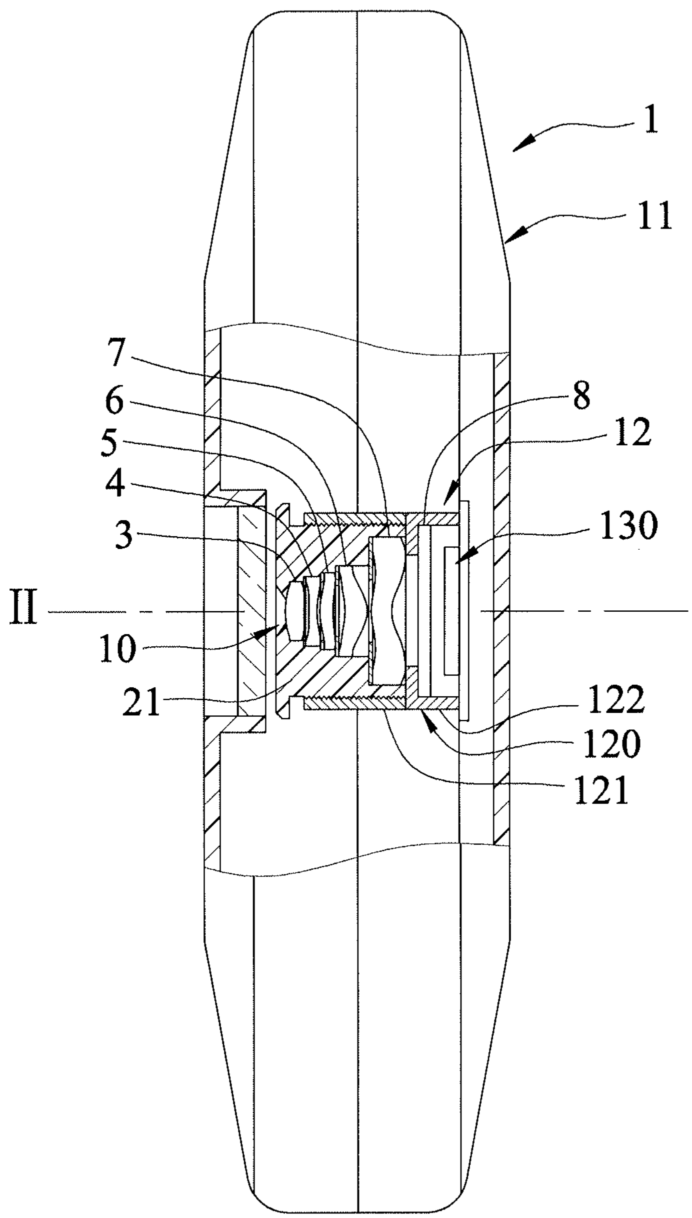

FIG.31

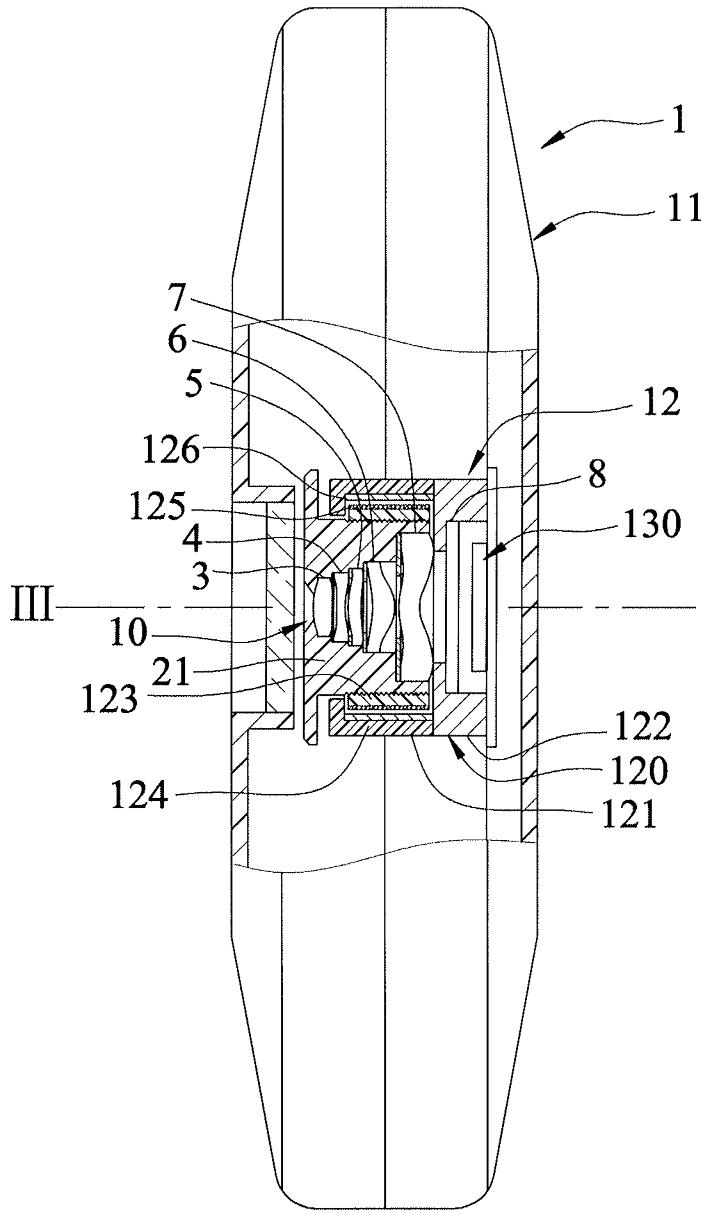

FIG.32

IMAGING LENS, AND ELECTRONIC APPARATUS INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Chinese Application No. 201410085092.8, filed on Mar. 10, 2014.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an imaging lens and an electronic apparatus including the same.

2. Description of the Related Art

In recent years, as use of portable electronic devices (e.g., mobile phones and digital cameras) becomes ubiquitous, much effort has been put into reducing dimensions of portable electronic devices. Moreover, as dimensions of charged coupled device (CCD) and complementary metal-oxide semiconductor (CMOS) based optical sensors are reduced, dimensions of imaging lenses for use with the optical sensors must be correspondingly reduced without significantly compromising optical performance.

However, the conventional imaging lens with four lens elements is insufficient to satisfy consumer expectations of high image quality. It is desirable to develop an imaging lens that has a relatively small size and relatively high image quality.

Each of U.S. Pat. Nos. 7,480,105, 7,639,432, 7,486,449 and 7,684,127 discloses a type of an imaging lens that includes five lens elements. In each of U.S. Pat. Nos. 7,480,105 and 7,639,432, the first two lens elements of the imaging lens disclosed therein respectively have a negative refractive power and a positive refractive power. In each of U.S. Pat. Nos. 7,486,449 and 7,684,127, both of the first two lens elements of the imaging lens disclosed therein have a negative refractive power. However, the aforesaid arrangement of the first two lens elements is unable to achieve good optical performance. Beside, the imaging lenses disclosed in the aforesaid patents have a system length ranging between 10 mm and 18 mm, which disfavors reducing thickness of portable electronic devices.

Reducing the system length of the imaging lens while maintaining satisfactory optical performance is always a goal in the industry.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide an imaging lens having a shorter overall length while maintaining good optical performance.

According to one aspect of the present invention, an imaging lens comprises an aperture stop, a first lens element, a second lens element, a third lens element, a fourth lens element and a fifth lens element arranged in order from an object side to an image side along an optical axis of the imaging lens. Each of the first lens element, the second lens element, the third lens element, the fourth lens element and the fifth lens element has a refractive power, an object-side surface facing toward the object side, and an image-side surface facing toward the image side.

The first lens element has a positive refractive power, and the object-side surface of the first lens element is a convex surface that has a convex portion in a vicinity of the optical axis and a convex portion in a vicinity of a periphery of the first lens element.

The second lens element has a negative refractive power, and the object-side surface of the second lens element has a concave portion in a vicinity of a periphery of the second lens element.

The image-side surface of the third lens element has a concave portion in a vicinity of the optical axis.

The object-side surface of the fourth lens element has a concave portion in a vicinity of a periphery of the fourth lens element, and the image-side surface of the fourth lens element has a convex portion in a vicinity of the optical axis.

The object-side surface of the fifth lens element has a convex portion in a vicinity of the optical axis, and the image-side surface of the fifth lens element has a concave portion in a vicinity of the optical axis, and a convex portion in a vicinity of a periphery of the fifth lens element.

The imaging lens does not include any lens element with a refractive power other than the first lens element, the second lens element, the third lens element, the fourth lens element and the fifth lens element.

The imaging lens satisfies $T4/G34 \geq 1.60$, where **T4** represents a thickness of the fourth lens element at the optical axis, and **G34** represents an air gap width between the third lens element and the fourth lens element at the optical axis.

Another object of the present invention is to provide an electronic apparatus having an imaging lens with five lens elements.

According to another aspect of the present invention, an electronic apparatus includes a housing and an imaging module. The imaging module is disposed in the housing, and includes the imaging lens of the present invention, a barrel on which the imaging lens is disposed, a holder unit on which the barrel is disposed, and an image sensor disposed at the image side of the imaging lens.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiments with reference to the accompanying drawings, of which:

FIG. **1** is a schematic diagram to illustrate the structure of a lens element;

FIG. **2** is a schematic diagram that illustrates the first preferred embodiment of an imaging lens according to the present invention;

FIG. **3** shows values of some optical data corresponding to the imaging lens of the first preferred embodiment;

FIG. **4** shows values of some aspherical coefficients corresponding to the imaging lens of the first preferred embodiment;

FIGS. **5**(*a*) to **5**(*d*) show different optical characteristics of the imaging lens of the first preferred embodiment;

FIG. **6** is a schematic diagram that illustrates the second preferred embodiment of an imaging lens according to the present invention;

FIG. **7** shows values of some optical data corresponding to the imaging lens of the second preferred embodiment;

FIG. **8** shows values of some aspherical coefficients corresponding to the imaging lens of the second preferred embodiment;

FIGS. **9**(*a*) to **9**(*d*) show different optical characteristics of the imaging lens of the second preferred embodiment;

FIG. **10** is a schematic diagram that illustrates the third preferred embodiment of an imaging lens according to the present invention;

FIG. **11** shows values of some optical data corresponding to the imaging lens of the third preferred embodiment;

FIG. **12** shows values of some aspherical coefficients corresponding to the imaging lens of the third preferred embodiment;

FIGS. **13**(*a*) to **13**(*d*) show different optical characteristics of the imaging lens of the third preferred embodiment;

FIG. **14** is a schematic diagram that illustrates the fourth preferred embodiment of an imaging lens according to the present invention;

FIG. **15** shows values of some optical data corresponding to the imaging lens of the fourth preferred embodiment;

FIG. **16** shows values of some aspherical coefficients corresponding to the imaging lens of the fourth preferred embodiment;

FIGS. **17**(*a*) to **17**(*d*) show different optical characteristics of the imaging lens of the fourth preferred embodiment;

FIG. **18** is a schematic diagram that illustrates the fifth preferred embodiment of an imaging lens according to the present invention;

FIG. **19** shows values of some optical data corresponding to the imaging lens of the fifth preferred embodiment;

FIG. **20** shows values of some aspherical coefficients corresponding to the imaging lens of the fifth preferred embodiment;

FIGS. **21**(*a*) to **21**(*d*) show different optical characteristics of the imaging lens of the fifth preferred embodiment;

FIG. **22** is a schematic diagram that illustrates the sixth preferred embodiment of an imaging lens according to the present invention;

FIG. **23** shows values of some optical data corresponding to the imaging lens of the sixth preferred embodiment;

FIG. **24** shows values of some aspherical coefficients corresponding to the imaging lens of the sixth preferred embodiment;

FIGS. **25**(*a*) to **25**(*d*) show different optical characteristics of the imaging lens of the sixth preferred embodiment;

FIG. **26** is a schematic diagram that illustrates the seventh preferred embodiment of an imaging lens according to the present invention;

FIG. **27** shows values of some optical data corresponding to the imaging lens of the seventh preferred embodiment;

FIG. **28** shows values of some aspherical coefficients corresponding to the imaging lens of the seventh preferred embodiment;

FIGS. **29**(*a*) to **29**(*d*) show different optical characteristics of the imaging lens of the seventh preferred embodiment;

FIG. **30** is a table that lists values of relationships among some lens parameters corresponding to the imaging lenses of the first to seventh preferred embodiments;

FIG. **31** is a schematic partly sectional view to illustrate a first exemplary application of the imaging lens of the present invention; and

FIG. **32** is a schematic partly sectional view to illustrate a second exemplary application of the imaging lens of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before the present invention is described in greater detail, it should be noted that like elements are denoted by the same reference numerals throughout the disclosure.

In the following description, "a lens element has a positive (or negative) refractive power" means the lens element has a positive (or negative) refractive power in a vicinity of an optical axis thereof. "An object-side surface (or image-side surface) has a convex (or concave) portion at a certain area" means that, compared to a radially exterior area adjacent to said certain area, said certain area is more convex (or concave) in a direction parallel to the optical axis. Referring to FIG. **1** as an example, the lens element is radially symmetrical with respect to an optical axis (I) thereof. The object-side surface of the lens element has a convex portion at an area A, a concave portion at an area B, and a convex portion at an area C. This is because the area A is more convex in a direction parallel to the optical axis (I) in comparison with a radially exterior area thereof (i.e., area B), the area B is more concave in comparison with the area C, and the area C is more convex in comparison with an area E. "In a vicinity of a periphery" refers to an area around a periphery of a curved surface of the lens element for passage of imaging light only, which is the area C in FIG. **1**. The imaging light includes a chief ray Lc and a marginal ray Lm. "In a vicinity of the optical axis" refers to an area around the optical axis of the curved surface for passage of the imaging light only, which is the area A in FIG. **1**. In addition, the lens element further includes an extending portion E for installation into an optical imaging lens device. Ideally, the imaging light does not pass through the extending portion E. The structure and shape of the extending portion E are not limited herein. In the following embodiments, the extending portion E is not depicted in the drawings for the sake of clarity.

Referring to FIG. **2**, the first preferred embodiment of an imaging lens **10** according to the present invention includes an aperture stop **2**, a first lens element **3**, a second lens element **4**, a third lens element **5**, a fourth lens element **6**, a fifth lens element **7**, and an optical filter **8** arranged in the given order along an optical axis (I) from an object side to an image side. The optical filter **8** is an infrared cut filter for selectively absorbing infrared light to thereby reduce imperfection of images formed at an image plane **100**.

Each of the first, second, third, fourth and fifth lens elements **3-7** and the optical filter **8** has an object-side surface **31**, **41**, **51**, **61**, **71**, **81** facing toward the object side, and an image-side surface **32**, **42**, **52**, **62**, **72**, **82** facing toward the image side. Light entering the imaging lens **10** travels through the aperture stop **2**, the object-side and image-side surfaces **31**, **32** of the first lens element **3**, the object-side and image-side surfaces **41**, **42** of the second lens element **4**, the object-side and image-side surfaces **51**, **52** of the third lens element **5**, the object-side and image-side surfaces **61**, **62** of the fourth lens element **6**, the object-side and image-side surfaces **71**, **72** of the fifth lens element **7**, and the object-side and image-side surfaces **81**, **82** of the optical filter **8**, in the given order, to form an image on the image plane **100**. Each of the object-side surfaces **31**, **41**, **51**, **61**, **71** and the image-side surfaces **32**, **42**, **52**, **62**, **72** is aspherical and has a center point coinciding with the optical axis (I).

Each of the lens elements **3-7** is made of a plastic material and has a refractive power in this embodiment. However, at least one of the lens elements **3-7** may be made of other materials in other embodiments.

In the first preferred embodiment, which is depicted in FIG. **2**, the first lens element **3** has a positive refractive power. The object-side surface **31** of the first lens element **3** is a convex surface that has a convex portion **311** in a vicinity of the optical axis (I) and that has a convex portion **312** in a vicinity of a periphery of the first lens element **3**. The image-side surface **32** of the first lens element **3** has a concave portion **321** in a vicinity of the optical axis (I), and a convex portion **322** in a vicinity of the periphery of the first lens element **3**.

The second lens element **4** has a negative refractive power. The object-side surface **41** of the second lens element **4** has a convex portion **411** in a vicinity of the optical axis (I), and a concave portion **412** in a vicinity of a periphery of the second lens element **4**. The image-side surface **42** of the second lens element **4** has a concave portion **421** in a vicinity of the optical axis (I), and a convex portion **422** in a vicinity of the periphery of the second lens element **4**.

The third lens element **5** has a positive refractive power. The object-side surface **51** of the third lens element **5** has a convex portion **511** in a vicinity of the optical axis (I), and a concave portion **512** in a vicinity of a periphery of the third lens element **5**. The image-side surface **52** of the third lens element **5** has a concave portion **521** in a vicinity of the optical axis (I), and a convex portion **522** in a vicinity of the periphery of the third lens element **5**.

The fourth lens element **6** has a positive refractive power. The object-side surface **61** of the fourth lens element **6** is a concave surface that has a concave portion **611** in a vicinity of the optical axis (I), and a concave portion **612** in a vicinity of a periphery of the fourth lens element **6**. The image-side surface **62** of the fourth lens element **6** is a convex surface that has a convex portion **621** in a vicinity of the optical axis (I), and a convex portion **622** in a vicinity of the periphery of the fourth lens element **6**.

The fifth lens element **7** has a negative refractive power. The object-side surface **71** of the fifth lens element **7** has a convex portion **711** in a vicinity of the optical axis (I), and a concave portion **712** in a vicinity of a periphery of the fifth lens element **7**. The image-side surface **72** of the fifth lens element **7** has a concave portion **721** in a vicinity of the optical axis (I), and a convex portion **722** in a vicinity of the periphery of the fifth lens element **7**.

In the first preferred embodiment, the imaging lens **10** does not include any lens element with a refractive power other than the aforesaid lens elements **3-7**.

Shown in FIG. **3** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the first preferred embodiment. The imaging lens **10** has an overall system effective focal length (EFL) of 2.6385 mm, a half field-of-view (HFOV) of 40.425°, an F-number of 2.05, and a system length of 3.9041 mm. The system length refers to a distance between the object-side surface **31** of the first lens element **3** and the image plane **100** at the optical axis (I).

In this embodiment, each of the object-side surfaces **31-71** and the image-side surfaces **32-72** is aspherical, and satisfies the relationship of

$$Z(Y) = \frac{Y^2}{R} \Bigg/ \left(1 + \sqrt{1 - (1+K)\frac{Y^2}{R^2}}\right) + \sum_{i=1}^{n} a_{2i} \times Y^{2i} \tag{1}$$

where:

R represents a radius of curvature of an aspherical surface;

Z represents a depth of the aspherical surface, which is defined as a perpendicular distance between an arbitrary point on the aspherical surface that is spaced apart from the optical axis (I) by a distance Y, and a tangent plane at a vertex of the aspherical surface at the optical axis (I);

Y represents a perpendicular distance between the arbitrary point on the aspherical surface and the optical axis (I);

K represents a conic constant; and

a_{2i} represents a $2i^{th}$ aspherical coefficient.

Shown in FIG. **4** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the first preferred embodiment.

Relationships among some of the lens parameters corresponding to the first preferred embodiment are listed in a column of FIG. **30** corresponding to the first preferred embodiment, where:

T**1** represents a thickness of the first lens element **3** at the optical axis (I);

T**2** represents a thickness of the second lens element **4** at the optical axis (I);

T**3** represents a thickness of the third lens element **5** at the optical axis (I);

T**4** represents a thickness of the fourth lens element **6** at the optical axis (I);

T**5** represents a thickness of the fifth lens element **7** at the optical axis (I);

G**12** represents an air gap width between the first lens element **3** and the second lens element **4** at the optical axis (I);

G**23** represents an air gap width between the second lens element **4** and the third lens element **5** at the optical axis (I);

G**34** represents an air gap width between the third lens element **5** and the fourth lens element **6** at the optical axis (I);

G**45** represents an air gap'width between the fourth lens element **6** and the fifth lens element **7** at the optical axis (I);

ALT represents a sum of thicknesses of the lens elements **3-7** at the optical axis (I), i.e., the sum of T**1**, T**2**, T**3**, T**4**, and T**5**;

Gaa represents a sum of four air gap widths among the first lens element **3**, the second lens element **4**, the third lens element **5**, the fourth lens element **6** and the fifth lens element **7** at the optical axis (I), i.e., the sum of G**12**, G**23**, G**34**, and G**45**; and

BFL represents a distance at the optical axis (I) between the image-side surface **72** of the fifth lens element **7** and the image plane **100** at the image side.

FIGS. **5**(*a*) to **5**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the first preferred embodiment. In each of the simulation results, curves corresponding respectively to wavelengths of 470 nm, 555 nm, and 650 nm are shown.

It can be understood from FIG. **5**(*a*) that, since each of the curves corresponding to longitudinal spherical aberration has a focal length at each field of view (indicated by the vertical axis) that falls within the range of ±0.02 mm, the first preferred embodiment is able to achieve a relatively low spherical aberration at each of the wavelengths. Furthermore, since the curves at each field of view are close to each other, the first preferred embodiment has a relatively low chromatic aberration.

It can be understood from FIGS. **5**(*b*) and **5**(*c*) that, since each of the curves falls within the range of ±0.2 mm of focal length, the first preferred embodiment has a relatively low optical aberration.

Moreover, as shown in FIG. **5**(*d*), since each of the curves corresponding to distortion aberration falls within the range of ±1%, the first preferred embodiment is able to meet requirements in imaging quality of most optical systems.

In view of the above, even with the system length reduced down to below 4.00 mm, the imaging lens **10** of the first preferred embodiment is still able to achieve a relatively good optical performance.

Referring to FIG. **6**, the differences between the first and second preferred embodiments of the imaging lens **10** of this invention reside in some of the optical data corresponding to the surfaces **31-81**, **32-82**, the lens parameters and the aspherical coefficients of the lens elements **3-7**.

Shown in FIG. **7** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the second preferred embodiment. The imaging lens **10** has an overall system focal length of 2.6174 mm, an HFOV of 40.650°, an F-number of 2.05, and a system length of 3.8859 mm.

Shown in FIG. **8** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the second preferred embodiment.

Relationships among some of the aforementioned lens parameters corresponding to the second preferred embodiment are listed in a column of FIG. **30** corresponding to the second preferred embodiment.

FIGS. **9**(*a*) to **9**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the second preferred embodiment. It can be understood from FIGS. **9**(*a*) to **9**(*d*) that the second preferred embodiment is able to achieve a relatively good optical performance.

Referring to FIG. **10**, the differences between the first and third preferred embodiments of the imaging lens **10** of this invention reside in some of the optical data corresponding to the surfaces **31-81**, **32-82**, the lens parameters, and the aspherical coefficients of the lens elements **3-7**.

Shown in FIG. **11** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the third preferred embodiment. The imaging lens **10** has an overall system focal length of 2.7389 mm, an HFOV of 39.421°, an F-number of 2.05, and a system length of 4.1354 mm.

Shown in FIG. **12** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the third preferred embodiment.

Relationships among some of the aforementioned lens parameters corresponding to the third preferred embodiment are listed in a column of FIG. **30** corresponding to the third preferred embodiment.

FIGS. **13**(*a*) to **13**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the third preferred embodiment. It can be understood from FIGS. **13**(*a*) to **13**(*d*) that the third preferred embodiment is able to achieve a relatively good optical performance.

Referring to FIG. **14**, the differences between the first and fourth preferred embodiments of the imaging lens **10** of this invention reside in some of the optical data corresponding to the surfaces **31-81**, **32-82**, the lens parameters, and the aspherical coefficients of the lens elements **3-7**.

Shown in FIG. **15** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the fourth preferred embodiment. The imaging lens **10** has an overall system focal length of 2.7359 mm, an HFOV of 39.385°, an F-number of 2.05, and a system length of 4.0700 mm.

Shown in FIG. **16** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the fourth preferred embodiment.

Relationships among some of the aforementioned lens parameters corresponding to the fourth preferred embodiment are listed in a column of FIG. **30** corresponding to the fourth preferred embodiment.

FIGS. **17**(*a*) to **17**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the fourth preferred embodiment. It can be understood from FIGS. **17**(*a*) to **17**(*d*) that the fourth preferred embodiment is able to achieve a relatively good optical performance.

Referring to FIG. **18**, the differences between the first and fifth preferred embodiments of the imaging lens **10** of this invention reside in some of the optical data corresponding to the surfaces **31-81**, **32-82**, the lens parameters, and the aspherical coefficients of the lens elements **3-7**. Besides, in the fifth preferred embodiment, the image-side surface **62** of the fourth lens element **6** has a convex portion **621** in a vicinity of the optical axis (I), and a concave portion **623** in a vicinity of a periphery of the fourth lens element **6**.

Shown in FIG. **19** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the fifth preferred embodiment. The imaging lens **10** has an overall system focal length of 2.6899 mm, an HFOV of 39.812°, an F-number of 2.05, and a system length of 3.9004 mm.

Shown in FIG. **20** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the fifth preferred embodiment.

Relationships among some of the aforementioned lens parameters corresponding to the fifth preferred embodiment are listed in a column of FIG. **30** corresponding to the fifth preferred embodiment.

FIGS. **21**(*a*) to **21**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the fifth preferred embodiment. It can be understood from FIGS. **21**(*a*) to **21**(*d*) that the fifth preferred embodiment is able to achieve a relatively good optical performance.

Referring to FIG. **22**, the differences between the first and sixth preferred embodiments of the imaging lens **10** of this invention reside in some of the optical data corresponding to the surfaces **31-81**, **32-82**, the lens parameters, and the aspherical coefficients of the lens elements **3-7**.

Shown in FIG. **23** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the sixth preferred embodiment. The imaging lens **10** has an overall system focal length of 2.7384 mm, an HFOV of 39.418°, an F-number of 2.05, and a system length of 4.1644 mm.

Shown in FIG. **24** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the sixth preferred embodiment.

Relationships among some of the aforementioned lens parameters corresponding to the sixth preferred embodiment are listed in a column of FIG. **30** corresponding to the sixth preferred embodiment.

FIGS. **25**(*a*) to **25**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the sixth preferred embodiment. It can be understood from FIGS. **25**(*a*) to **25**(*d*) that the sixth preferred embodiment is able to achieve a relatively good optical performance.

FIG. **26** illustrates the seventh preferred embodiment of an imaging lens **10** according to the present invention, which has a configuration similar to that of the first preferred embodiment. However, in this seventh preferred embodiment, the image-side surface **42** of the second lens element **4** has a concave portion **421** in a vicinity of the optical axis (I), and a concave portion **423** in a vicinity of a periphery of the second lens element **4**.

Shown in FIG. **27** is a table that lists values of some optical data corresponding to the surfaces **31-81**, **32-82** of the seventh preferred embodiment. The imaging lens **10** has an overall system focal length of 2.5570 mm, an HFOV of 41.121°, an F-number of 2.05, and a system length of 3.8139 mm.

Shown in FIG. **28** is a table that lists values of some aspherical coefficients of the aforementioned relationship (1) corresponding to the seventh preferred embodiment.

Relationships among some of the aforementioned lens parameters corresponding to the seventh preferred embodiment are listed in a column of FIG. **30** corresponding to the seventh preferred embodiment.

FIGS. **29**(*a*) to **29**(*d*) respectively show simulation results corresponding to longitudinal spherical aberration, sagittal astigmatism aberration, tangential astigmatism aberration, and distortion aberration of the seventh preferred embodiment. It can be understood from FIGS. **29**(*a*) to **29**(*d*) that the seventh preferred embodiment is able to achieve a relatively good optical performance.

Shown in FIG. **30** is a table that lists the aforesaid relationships among some of the aforementioned lens parameters corresponding to the seven preferred embodiments for comparison. It should be noted that the values of the lens parameters and the relationships listed in FIG. **30** are rounded off to the third decimal place.

When each of the lens parameters of the imaging lens **10** according to this invention satisfies the following optical relationships, the optical performance is still relatively good even with the reduced system length:

1. T**4**/G**34**≥1.60 and T**3**/G**34**≥1.10: In order to reduce the overall system length of the imaging lens **10**, reductions in T**3**, T**4** and G**34** are advantageous. However, although G**34** is readily reduced, reductions in T**3** and T**4** are limited due to manufacturing ability. In design, there is a tendency to have relatively larger values of T**4**/G**34** and T**3**/G**34**. Better arrangement may be achieved when these relationships are satisfied. Preferably, 1.6≤T**4**/G**34**≤5.0 and 1.1≤T**3**/G**34**≤2.5.

2. T**3**/G**23**≥1.80, T**2**/G**23**≥1.20, T**1**/G**23**≥2.80, T**4**/G**23**≥3.00, T**5**/G**23**≥2.55 and ALT/G**23**≥11.00: Similar to the above, reductions in T**1**, T**2**, T**3**, T**4**, T**5** and ALT are limited, while G**23** should be reduced as much as possible for reduction of the overall system length of the imaging lens **10**. Therefore, there is a tendency to have relatively larger values of T**3**/G**23**, T**2**/G**23**, T**1**/G**23**, T**4**/G**23**, T**5**/G**23** and ALT/G**23** in design. Better arrangement may be achieved when these relationships are satisfied. Preferably, 1.8≤T**3**/G**23**≤9.0, 1.2≤T**2**/G**23**≤5.0, 2.8≤T**1**/G**23**≤10.0, 2.55≤T**5**/G**23**≤12.0, 3.0T**4**/G**23**≤12.0 and 11.0≤ALT/G**23**≤50.0.

3. T**1**/Gaa≥0.65 and Gaa/T**2**≤3.00: Similar to the above aforesaid, Gaa should be reduced as much as possible for reduction of the overall system length of the imaging lens **10**. Therefore, T**1**/Gaa tends to have a relatively larger value, and Gaa/T**2** tends to have a relatively smaller value in design. Better arrangement may be achieved when these relationships are satisfied. Preferably, 0.65≤T**1**/Gaa≤1.1 and 1.8≤Gaa/T**2**≤3.0.

4. T**5**/T**4**≥0.70, ALT/T**1**≤5.00 and BFL/T**5**≤3.00: In order to prevent any one of the lens elements **3-7** from being too thick that disfavors reduction of the overall system length, and from being too thin that disfavors lens manufacture, T**5**/T**4**, ALT/T**1** and BFL/T**5** should be maintained at appropriate relationships, respectively. Better arrangement may be achieved when these relationships are satisfied. Preferably, 0.7≤T**5**/T**4**≤1.2, 4.0≤ALT/T**1**≤5.0 and 1.5≤BFL/T**5**≤3.0.

5. BFL/(G**12**+G**45**)≥3.00, (G**12**+G**45**)/G**23**≤4.00 and Gaa/(G**12**+G**45**)≥2.50: Since the image-side surface **62** of the fourth lens element **6** has the convex portion **621** in the vicinity of the optical axis (I) and the object-side surface **71** of the fifth lens element **7** has the convex portion **711** in the vicinity of the optical axis (I), G**45** can be reduced as much as possible in comparison with other air gap widths. In design, BFL/(G**12**+G**45**) and Gaa/(G**12**+G**45**) tend to have relatively larger values, and (G**12**+G**45**)/G**23** tends to have a relatively smaller value. Better arrangement may be achieved when these relationships are satisfied. Preferably, 3.0≤BFL/(G**12**+G**45**)≤10.0, 0.5≤(G**12**+G**45**)/G**23**≤4.0 and 2.5≤Gaa/(G**12**+G**45**)≤5.0.

To sum up, effects and advantages of the imaging lens **10** according to the present invention are described hereinafter.

1. The positive refractive power of the first lens element **3** contributes to the overall positive refractive power of the imaging lens **10**. The negative refractive power of the second lens element **2** is effective to correct image aberration. In addition, by virtue of the aperture stop **2** arranged in front of the object-side surface **31** of the first lens element **3**, converging ability may be enhanced, and the overall length of the imaging lens **10** may be reduced.

2. Through design of the relevant optical parameters, optical aberrations, such as spherical aberration, may be reduced or even eliminated. Moreover, by cooperation of the convex object-side surface **31** that favors collecting imaging lights, the concave portion **412**, the concave portion **521**, the concave portion **611**, the convex portion **621**, the convex portion **711**, the concave portion **721** and the convex portion **722**, image quality may be enhanced.

3. Through the aforesaid seven preferred embodiments, it is known that the system length of this invention may be reduced down to below 4.2 mm, so as to facilitate developing thinner relevant products with economic benefits.

Shown in FIG. **31** is a first exemplary application of the imaging lens **10**, in which the imaging lens **10** is disposed in a housing **11** of an electronic apparatus **1** (such as a mobile phone, but not limited thereto), and forms a part of an imaging module **12** of the electronic apparatus **1**.

The imaging module **12** includes a barrel **21** on which the imaging lens **10** is disposed, a holder unit **120** on which the barrel **21** is disposed, and an image sensor **130** disposed at the image plane **100** (see FIG. **2**).

The holder unit **120** includes a first holder portion **121** in which the barrel **21** is disposed, and a second holder portion **122** having a portion interposed between the first holder portion **121** and the image sensor **130**. The barrel **21** and the first holder portion **121** of the holder unit **120** extend along an axis (II), which coincides with the optical axis (I) of the imaging lens **10**.

Shown in FIG. **32** is a second exemplary application of the imaging lens **10**. The differences between the first and second exemplary applications reside in that, in the second exemplary application, the holder unit **120** is configured as a voice-coil motor (VCM), and the first holder portion **121** includes an inner section **123** in which the barrel **21** is disposed, an outer section **124** that surrounds the inner section **123**, a coil **125** that is interposed between the inner and outer sections **123**, **124**, and a magnetic component **126** that is disposed between an outer side of the coil **125** and an inner side of the outer section **124**.

The inner section **123** and the barrel **21**, together with the imaging lens **10** therein, are movable with respect to the image sensor **130** along an axis (III), which coincides with the optical axis (I) of the imaging lens **10**. The optical filter **8** of the imaging lens **10** is disposed at the second holder portion **122**, which is disposed to abut against the outer section **124**. Configuration and arrangement of other components of the electronic apparatus **1** in the second exemplary application are identical to those in the first exemplary application, and hence will not be described hereinafter for the sake of brevity.

By virtue of the imaging lens **10** of the present invention, the electronic apparatus **1** in each of the exemplary applications may be configured to have a relatively reduced overall thickness with good optical and imaging performance, so as to reduce cost of materials, and satisfy requirements of product miniaturization.

While the present invention has been described in connection with what are considered the most practical and preferred embodiments, it is understood that this invention is not limited to the disclosed embodiments but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation so as to encompass all such modifications and equivalent arrangements.

What is claimed is:

1. An imaging lens comprising an aperture stop, a first lens element, a second lens element, a third lens element, a fourth lens element and a fifth lens element arranged in order from an object side to an image side along an optical axis of said imaging lens, each of said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element having a refractive power, an object-side surface facing toward the object side, and an image-side surface facing toward the image side, wherein:

said first lens element has a positive refractive power, and said object-side surface of said first lens element is a convex surface that has a convex portion in a vicinity of the optical axis and a convex portion in a vicinity of a periphery of said first lens element;

said second lens element has a negative refractive power, and said object-side surface of said second lens element has a concave portion in a vicinity of a periphery of said second lens element;

said image-side surface of said third lens element has a concave portion in a vicinity of the optical axis;

said object-side surface of said fourth lens element has a concave portion in a vicinity of a periphery of said fourth lens element, said fourth lens element has a positive refractive power, and said image-side surface of said fourth lens element has a convex portion in a vicinity of the optical axis;

said object-side surface of said fifth lens element has a convex portion in a vicinity of the optical axis, and said image-side surface of said fifth lens element has a concave portion in a vicinity of the optical axis, and a convex portion in a vicinity of a periphery of said fifth lens element;

said imaging lens does not include any lens element with a refractive power other than said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element;

said imaging lens satisfies T4/G34≥1.60, where T4 represents a thickness of said fourth lens element at the optical axis, and G34 represents an air gap width between said third lens element and said fourth lens element at the optical axis; and

said imaging lens further satisfies T4/G23≥3.00, where G23 represents an air gap width between said second lens element and said third lens element at the optical axis.

2. The imaging lens as claimed in claim **1**, further satisfying T5/T4≥0.70, where T5 represents a thickness of said fifth lens element at the optical axis.

3. The imaging lens as claimed in claim **2**, further satisfying T3/G23≥1.80, where T3 represents a thickness of said third lens element at the optical axis.

4. The imaging lens as claimed in claim **3**, further satisfying T1/Gaa≥0.65, where T1 represents a thickness of said first lens element at the optical axis, and Gaa represents a sum of four air gap widths among said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element at the optical axis.

5. The imaging lens as claimed in claim **3**, further satisfying T2/G23≥1.20, where T2 represents a thickness of said second lens element at the optical axis.

6. The imaging lens as claimed in claim **5**, further satisfying ALT/T1≤5.00, where T1 represents a thickness of said first lens element at the optical axis, and ALT represents a sum of thicknesses of said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element at the optical axis.

7. The imaging lens as claimed in claim **1**, further satisfying BFL/(G12+G45)≥3.00, where BFL represents a distance at the optical axis between said image-side surface of said fifth lens element and an image plane at the image side, G12 represents an air gap width between said first lens element and said second lens element at the optical axis, and G45 represents an air gap width between said fourth lens element and said fifth lens element at the optical axis.

8. The imaging lens as claimed in claim **7**, further satisfying T3/G34≥1.10, where T3 represents a thickness of said third lens element at the optical axis.

9. The imaging lens as claimed in claim **8**, further satisfying T1/G23≥2.80, where T1 represents a thickness of said first lens element at the optical axis.

10. The imaging lens as claimed in claim **9**, further satisfying (G12+G45)/G23≥4.00.

11. The imaging lens as claimed in claim **9**, further satisfying BFL/T5≤3.00, where T5 represents a thickness of said fifth lens element at the optical axis.

12. The imaging lens as claimed in claim **1**, further satisfying T3/G23≥1.80, where T3 represents a thickness of said third lens element at the optical axis.

13. The imaging lens as claimed in claim **12**, further satisfying Gaa/(G12+G45)≥2.50, where Gaa represents a sum of four air gap widths among said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element at the optical axis, G12 represents the air gap width between said first lens element and said second lens element at the optical axis, and G45 represents the air gap width between said fourth lens element and said fifth lens element at the optical axis.

14. The imaging lens as claimed in claim **13**, further satisfying T5/G23≥2.55, where T5 represents a thickness of said fifth lens element at the optical axis.

15. The imaging lens as claimed in claim **13**, further satisfying Gaa/T2≤3.00, where T2 represents a thickness of said second lens element at the optical axis.

16. The imaging lens as claimed in claim **1**, further satisfying T3/G34≥1.10, where T3 represents a thickness of said third lens element at the optical axis.

17. The imaging lens as claimed in claim **16**, further satisfying T5/T4≥0.70, where T5 represents a thickness of said fifth lens element at the optical axis.

18. The imaging lens as claimed in claim **17**, further satisfying ALT/G23≥11.00, where ALT represents a sum of thicknesses of said first lens element, said second lens element, said third lens element, said fourth lens element and said fifth lens element at the optical axis.

19. An electronic apparatus comprising:

a housing; and

an imaging module disposed in said housing, and including an imaging lens as claimed in claim **1**, a barrel on which said imaging lens is disposed, a holder unit on which said barrel is disposed, and an image sensor disposed at the image side of said imaging lens.

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